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COLOUR TELEVISION BROADCASTING

ALTHOUGH PRIMITIVE MAN ACHIEVED STRIKING realism in his charcoal drawings on the limestone walls of his cave, as we can see in the Aurignac district of France, he was not satisfied until he had added colour. Colour is usually essential to full appreciation of a scene, and the main uncertainty hanging over television broadcasting in the United Kingdom is not whether colour will come but how long it will be delayed. For this delay there are many good reasons, in which cost, complexity, acceptability and the interests of the established monochrome television audience are inextricably mixed. As on the cinema screen, it is most unlikely that colour television pictures will ever oust black-and-white ones completely.

Systems of colour transmission have been proposed in which the colours are represented by coded values, but the realization of these systems in practice lies very far ahead. Any practicable development within the foreseeable future is likely to require the transmission of information sufficient to enable images in the three additive primary colours of green, red and blue to be derived. This means that colour transmission necessarily makes greater demands than does black-and-white on the equipment in the studio or at the outside broadcast, on spectrum space and on the receiving equipment. The complexity at the originating point means heavy extra cost to the broadcasting authority. As more information has to be transmitted, it means either that more spectrum space must be used or that the information must be crowded into the existing space, with perhaps some loss of fidelity. At the receiving end, colour demands a receiver with many more components than a black-and-white receiver, and this added complication is likely to mean more controls, which an ordinary person may have difficulty in handling effectively. The initial and running costs of the receiver are bound to be high; it is indeed unlikely that, failing some revolutionary new approach, the purchase price in Britain of a colour receiver will be much less than twice that of a black-and-white receiver of similar size.

In spite of all these difficulties, colour television broadcasting is certain to start in Britain ultimately, but when this does happen, it will be many years before the number of colour receivers in use can begin to compare with the number of black-and-white ones. Indeed, owing to cost, the sale of colour receivers will probably always be lower. Should, therefore, the transmission standards of the colour signal be related to the existing 405-line black-and-white standards? If they are, the quality of reproduction will be less good than it could be, but it may still be acceptable, and the owner of an ordinary black-and-white set will be able to receive the colour pictures in black-and-white. If the standards are not related, then a better-quality colour picture is theoretically possible but this picture will no longer be compatible, and the viewer who wishes to receive both transmissions will need two receivers.

At present, regular transmissions of colour television are taking place only in the United States. There are about two or three hours of colour programmes each evening on one or other of the networks, but, so far, less than 200 000 colour receivers have been sold. The only picture-tube at present available is the three-gun shadow-mask tube, although there is talk of interesting developments by other manufacturers. The American public does indeed appear to be waiting for the development of a simpler and cheaper set before giving wholehearted support to colour television. The transmitting system approved by the Federal Communications Commission for public service was developed by the National Television System Committee set up by the radio industry. This system is fully compatible. There is a slight loss of quality when a colour picture is reproduced in black-and-white as compared with a normal black-and-white transmission, but this has not caused any unfavourable reaction from the public.

In the United Kingdom, the Postmaster General has asked the Television Advisory Committee to report on the whole field of colour television broadcasting. The B.B.C. has been occupied on a general study of colour for some years, and in the past eighteen months it has radiated test transmissions from the Alexandra Palace and later the Crystal Palace transmitters. These tests, which have been carried out in co-operation with the radio industry, have been primarily directed towards the assessment of the acceptability of colour television using the American N.T.S.C. system adapted for the British 405-line 50-frame standards. The transmissions have been viewed on special receivers developed by the B.B.C. and by industry. Demonstrations have been given to Members of Parliament and to a Study Group of the International Radio Consultative Committee, and comments so far have been generally favourable. But, as a discussion on the subject last April before the Radio and Telecommunication Section clearly underlined, not all television engineers favour the adoption of a modified form of N.T.S.C. system in this country. It may well be that Britain should not be in a hurry to come to a decision that would commit her for many years ahead; there is room for development of both a new camera and a new display device. Meanwhile, the B.B.C. is continuing its tests, and in any event a report from the Television Advisory Committee on what course this country should adopt appears unlikely before next year.

THE HEAT PUMP

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In the April issue of the Journal Mr. J. A. Sumner described the beneficial effect that the widespread use of heat pumps could have on the national economy. In this article, Miss Miriam V. Griffith, who is with the Electrical Research Association, describes the theory and practice of modern heat pumps and the commonly available sources of low-grade heat. The article is based on the author's paper (No. 2273) entitled 'Some Aspects of Heat Pump Operation in Great Britain', which was read before a meeting of the Utilization Section on the 10th January 1957, and republished in Part A of the Proceedings in June 1957, p. 262.

MIRIAM V. GRIFFITH, B.SC., F.INST.P.

In 1852 Lord Kelvin made the suggestion that the reversed heat-engine cycle or heat pump might be used to keep a room warm. In 1881 he expressed his disappointment that the cycle had so far been used only for cooling purposes and said that he looked forward to the time when electricity would be available, because, as he said, 'When Niagara is set to work for the benefit of N. America it will no doubt be largely employed for the warming of houses, . . . to multiply the heat of coal and other fuel'. It is only, however, within the last two decades that any real effort has been made to develop Kelvin's ideas.

In all thermal processes involving a cycle, that due to Carnot may be used as the ultimate standard of reference. Carnot conceived a closed reversible cycle in which (1) a working substance receives heat only at the higher constant temperature of the hot source; (2) while expanding and doing external work it is cooled by adiabatic expansion; (3) it gives out heat only during isothermal compression at the lower constant temperature of the system; (4) it is raised in temperature by adiabatic compression, i.e. it is brought back to its initial state of volume, temperature, pressure and physical properties, and in this state it must contain the same quantity of heat which it had originally.

In the ideal engine the hot body and the cold body both have infinite thermal capacity so that no change of temperature takes place. If a perfect gas is taken as the working fluid, and W and Q_1 are the work done and the heat received respectively, the thermal efficiency of the cycle is given by

$$W/Q_1 = (T_1 - T_2)/T_1$$

where T_1 and T_2 are the temperatures of source and sink in degrees Kelvin.

If the process is reversed, i.e. heat is extracted from a cold body and rejected to a hot body, the path followed by the cycle is the same and $Q_1/W = T_1/(T_1 - T_2)$, where Q_1 is the heat rejected to the hot body.

This transfer or pumping of heat from a cold to a hot body is not contrary to the second law of thermodynamics, because an external agency in the form of a compressing engine is introduced into the system. A machine operating on this cycle is called a heat pump.

The advantage of the system as a method of providing space or process warming at a useful temperature is evident if some numerical values are put into the simple equation, $Q_1/W = T_1/(T_1 - T_2)$. If $T_1 = 50°C$ (323° K) and $T_2 = 10°C$ (283° K), the ratio of the heat output Q_1 to the external work done on the system, both expressed in heat units, will be nearly 8·1.

If electricity is supplied at the rate of 1 kW to warm water directly from 10° C to 50° C, only 47·6 lb can be heated in one hour. If the electricity is supplied to an electric motor and this is used to drive a compressor, both being assumed to work at 100% efficiency, then 386 lb of water can be heated from 10° C to 50° C in the same time.

These values of T_1 and T_2 have been taken as representative of temperatures which are used in heat pump practice. The higher temperature T_1 is determined by the duty required from the heat pump, and, other things being equal, this duty should be adapted where possible for operation at the lowest value of T_1 which can be accepted, in order to keep $T_1 - T_2$ as small as possible, and therefore the efficiency as high as possible.

The Heat Source and its Temperature

The heat output over and above the equivalent of the energy supplied to drive the compressor of the heat pump must be obtained by cooling suitable sources of low-grade heat. In order to keep $T_1 - T_2$ small, T_2 should be as high as possible. The importance of this is illustrated by Table 1.

Table 1. Variation in Heat-Pump Performance with Source Temperature

T_1	T_2	$T_1 - T_2$	Carnot ratio $T_1/(T_1 - T_2)$*	Practical value of ratio
°F	°F	°F		
140	80	60	10·0	5·0
	60	80	7·5	3·8
	40	100	6·0	3·0
	20	120	5·0	2·5

* Ratio calculated in degrees Kelvin.

The first heat pump made used atmospheric air as the heat source. This is cheap and convenient, but, because of the low thermal capacity of air, large surfaces are required for heat absorption. If the heat pump is required for space heating, the temperature of the air, and hence the advantage of using the heat pump, is lowest at the time of greatest need. Air temperature is also very

variable. In Britain, however, the temperature rarely falls so low that there is danger of inadequate heating.

It has been estimated that the whole of the heating needs of London could be met if a heat pump was used to cool the Thames only a few degrees. The flowing water of rivers or streams is indeed the most convenient source of low grade heat. The continual movement ensures that the local temperature is kept constant, while modern industrial practice tends to keep river-water temperature above the ambient even in the coldest weather by passing into it high-temperature effluents.

If the water is not moving, i.e. if it is present as a lake or a pond, the feasibility of using it depends on the relative size of the heat demand and the water quantity, and on how the water level is maintained. If there is an appreciable flow-through, the position approaches that of rivers. If the pond or lake is fed only by ground drainage it would be dangerous to use it with a heat pump of any appreciable capacity, since all the water would freeze, say in 48 hours, in low-ambient conditions. Although the latent heat of fusion may be thought to be of advantage, operation would stop while the ice melted.

Solid materials such as the soil can be cooled by buried pipes, as in Fig. 1. Temperatures are high at considerable depths, but local heat transfer is not good. The surface layers of the soil have a lower average temperature, but the rate of make-up heat from absorbed solar radiation, rain and natural soil drainage offers a better chance of continuous operation.

Sources such as those above are usually called natural heat sources. They have the advantage of quantity, but their temperatures tend to be low.

To prevent waste of fuel, and to take advantage of the heat pump, industrial waste heat which is available at temperatures of the order of 26° C (80° F) should be used where possible. If $T_1 = 50°\,C\,(323°\,K)$ and $T_2 = 26°\,C$ (299° K), $T_1/(T_1 - T_2) = 13{\cdot}5$ with an ideal heat pump.

The ratio $Q_1/W = T_1/(T_1 - T_2)$ is now widely known as the *performance energy ratio* or p.e.r. The term *coefficient of performance* used in refrigeration practice is actually $Q_2/W = T_2/(T_1 - T_2)$ and therefore should not be used for the heat pump.

The Practical Cycle of the Heat Pump

The first heat pump was operated by means of heating and cooling processes produced by the adiabatic expansion and compression of air.

Considerable reduction in size can be achieved, however, if the so-called vapour-compression cycle is used. Instead of direct heating of air, with a consequent large range of temperature at the supposedly isothermal stages, the changes of state from liquid to vapour and vapour to liquid can be contrived at the required temperatures by the use of suitable chemicals known as refrigerants. This nomenclature exists because development of the heat pump occurred first along the lines of refrigeration rather than for heating purposes, a refrigerator being of course a heat pump operating over a small range of temperature. In this instance, however, the cooling duty is the most important, the extracted heat usually being thrown away.

1 *The earth as a heat source (pipes in clay soil)*

Suitable refrigerants boil at a low temperature T_2 and a low pressure P_2 and condense at a higher temperature T_1 and a pressure P_1 which is not too high. For example, if $T_2 = 30°$ F, P_2 might be 30 lb/inch²; if $T_1 = 140°$ F, P_1 might be 200 lb/inch².

A vapour compression machine (Fig. 2, p. 375) consists of four essential parts:

(1) A compressor into which vapour is drawn through a suction valve from the evaporator at a low temperature T_2 and pressure P_2, compressed to the higher temperature T_1 and pressure P_1, and discharged through the delivery valve. The compressor is driven by a heat engine supplied with external energy.

(2) A condensing heat exchanger, or cooler, in which the compressed vapour is cooled and condensed, giving up its heat to water or air.

(3) An expansion device, which in practice is not an expansion cylinder but an adjustable throttle valve, through which the liquid expands from T_1 to T_2.

(4) An evaporating heat exchanger, or low-temperature boiler. The liquid evaporates in this, taking its heat directly from circulating water, from air blown over the coils, or from a secondary fluid such as brine, which may carry low-grade heat from a distance as in the case of the ground heat source.

The heat-pump vapour cycle approaches more nearly the reversed Rankine cycle than the Carnot cycle. This consists of an adiabatic compression, an irreversible expansion at constant enthalpy, and two heat-transfer processes at constant pressure.

The maximum p.e.r. of the reversed Rankine cycle is given by $(h_2 - h_3)/(h_2 - h_1)$,

where h_1 = total heat of the vapour at the beginning of compression, i.e. it includes heat absorbed from the source;
h_2 = total heat at the end of compression;
h_3 = total heat remaining in the condensed vapour after heat has been abstracted for the required purpose.

The quantity $(h_2 - h_3)/(h_2 - h_1)$ is always less than $T_1/(T_1 - T_2)$, since no other cycle can be more efficient than Carnot's. The values of h for many suitable chemical substances have been found by experiment and are published in tables and graphs.

The p.e.r. is further reduced by the difference of temperature necessary for the transfer of heat through the walls of heat exchangers of practical size. The efficiency of heat transfer may be written η_H. The adiabatic efficiency η_C of the compressor will be less than 100%, and also will vary with the P_1/P_2 ratio. The engine which drives the compressor will have a mechanical efficiency η_m, also less than 100%.

Taking these efficiencies into account, the p.e.r. of a practical heat pump is equal to

$$\eta_H \eta_C \eta_m (h_2 - h_3)/(h_2 - h_1)$$

η_H may be 90%, η_m 95% and η_C 80%, and hence this expression becomes $0{\cdot}68\ (h_2 - h_3)/(h_2 - h_1)$. The ratio $(h_2 - h_3)/(h_2 - h_1)$ will vary with the refrigerant used, but will be about $0{\cdot}8T_1/(T_1 - T_2)$.

This means that the nearest possible approach to the ideal performance of a heat pump which is likely to be achieved, is given by $0{\cdot}5T_1/(T_1 - T_2)$ for the temperature range concerned.

In some reported cases such values have already been found; in others performance is only 30% of the ideal.

The Compression Process

The theoretical p.e.r. will vary with the state of the cool low-pressure vapour entering the compressor.

Expressions for the p.e.r. in terms of L_1 and L_2, the latent heats at temperatures T_1 and T_2, S the specific heat of the liquid, and c_p the specific heat at constant pressure of the vapour, can be found for the cases of (*a*) slightly wet vapour compression, (*b*) 'just-dry' vapour compression and (*c*) slightly superheated vapour compression. The best performance theoretically should be found for (*a*). In practical machines, however, there is an interchange of heat between the vapour and the walls of the compressor cylinder, and this heat transfer is less with dry than with wet vapour. With saturated vapour in the cylinder at the end of the stroke, clearance losses may be greater than with superheated vapour. If the vapour is not superheated when it enters the compressor, liquid slugs may evaporate violently when pressure is released causing mechanical damage to the compressor itself.

Generally, absorption of heat by evaporation in the compressor counterbalances the slight theoretical advantage of wet compression. In practice, from 3° to 6°C of superheat (depending on the refrigerant) are arranged for as the vapour enters the compressor.

The Refrigerant

The performance of the compressor is most affected by the refrigerant, that of the heat exchangers very little. A compressor will pump only a certain volume, and the amount of heat picked up will therefore depend on the latent heat and the volume per pound of the refrigerant. If the condensing pressure is high for a certain value of T_1, heavy and costly equipment and piping is necessary. If the evaporating pressure is below atmospheric for a certain value of T_2, leakage hazards increase; air can enter and cause useless heating; moisture can enter and cause corrosion and other troubles.

A good refrigerant should have no effect on metal or oil, if possible. It is better if it is non-poisonous and non-inflammable and not too costly should leaks occur.

Freon-12, or Arcton-9,* has many advantages and is greatly used to-day. Although it has a low latent heat per pound, the vapour is heavy, and a given compressor will handle a large weight. It has no appreciable smell and periodic checking for leaks is therefore necessary. But it is a powerful solvent, and if used with dirty pipes will become adulterated and fall in performance. It is miscible with oil, which it will dilute, so that care must be taken to preserve adequate lubrication. Other members of the Freon family, F-11, F-22, etc., have somewhat different pressure/temperature relationships and are used where suitable.

Heat Exchangers

Attempts should not be made to reduce the cost of heat exchangers by reducing the heat transfer surface, because the effective value of $T_1 - T_2$ will increase, with a consequent fall in p.e.r.

The required rate of circulation of the working fluid must be provided without excessive frictional pressure drop. There should be enough room in the evaporator to allow vapour and liquid to separate, so that the liquid does not boil over and pass on to the compressor.

If oil is deposited on heat-exchanger surfaces, particularly if moisture is present, it may form an insulating layer. Oil separators and other devices are usually provided to return the oil to the compressor crankcase.

British Heat-Pump Practice

Preliminary investigations in Great Britain were devoted to a study of the simple vapour-compression cycle for a range of source temperatures from 40°F (4·4°C) to 85°F (29·5°C) in order to establish the range of practical p.e.r.'s that could be obtained, the high-temperature end of the range being of particular interest.

In view of the unique fuel-saving characteristics of the heat pump, it was essential to study also the natural sources of low-grade heat available in Great Britain in

* Freon-12 and Arcton-9 are American and British names for the same substance, dichlorodifluoromethane.

order to satisfy possible public demand for installations where highly favourable sources were not available. Particular attention was paid to the possibility of abstracting heat from the soil. The main object was to establish a design figure in heat units per unit length of buried pipe of optimum diameter for various soils for a range of expected moisture contents. The results obtained were very similar to those reported from other parts of the world, i.e. a grid of pipes buried horizontally at depths of 3–6 ft below the ground surface will pick up 30 B.t.u. per lineal foot of $\frac{3}{4}$-inch diameter pipe. The pipes should be at least 12 inches apart.

It soon became clear, however, that for practical reasons the soil as a source of low-grade heat was mainly suitable for new buildings where the cost of excavating could form part of a major scheme. The system would also become impracticably cumbersome for installations of output exceeding 25 kW.

The use of water as a heat source presents no new problems.

The air-source heat pump depends for its operation on the ability of the evaporator to extract heat from the air, cooling it below the ambient air temperature. The heat which is taken from the air comprises the sensible heat of the air plus that of the water vapour present in it, and the latent heat of water vapour condensed on the cool surfaces of the evaporator.

The latent heat is released only if the evaporator surface is below the dew point of the humid air. It can provide an appreciable portion of the heat pick-up. If the temperature of the evaporator surface falls below freezing point, the latent heat of fusion is added to the latent heat of condensation, but the deposition of frost will alter the operating characteristics of the evaporator.

Frost has three main effects:

(1) a change in dimensions and shape of the air side of the evaporator,

(2) the insulating effect of the frost coating, and

(3) the total heat transfer due to release of latent heat.

Frost is a very variable substance. Its character will be affected by rate of deposition, air velocity and turbulence, and air and frost temperatures. If it forms to such an extent that heat exchange deteriorates appreciably, it must be removed, usually by the use of additional energy. For any set of operating conditions a compromise between cost, size and efficiency is usually necessary. With the heat pump it is particularly important to make the correct balance between operating cost and capital cost.

Research has been carried out on the rate of condensation of dew and frost and on the physical properties of the frost produced by the conditions applying to heat-pump evaporators.

Practical Installations

Present installations in Great Britain fall into three main groups:

(1) Output ratings of 25–2 500 kW for small and large public buildings.

(2) Output ratings of 5–20 kW for residential central heating.

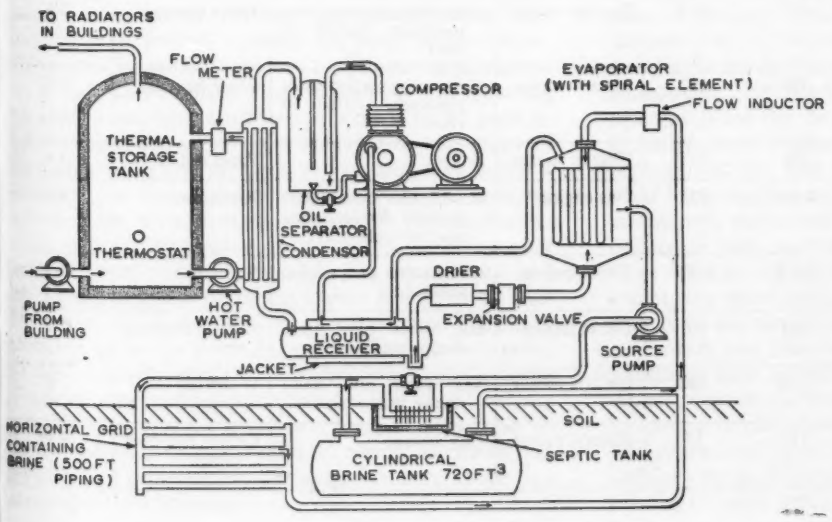
(3) Output ratings of 1–3 kW for single rooms and water heating.

Some details are given in Table 2.

The Economics of Heat Pump Applications in Great Britain

Under present conditions the deterring influence of high capital cost is very powerful in affecting the application of the heat pump in Great Britain. This is particularly so for heat pumps likely to operate with a low annual load factor, i.e. those designed for space-heating only.

If, however, a potential heat pump can be arranged to



2 *Schematic of heat pump using earth source*

perform two useful duties, either simultaneously or alternatively, the prospect is much better, and development of the application need only wait upon opportunity. Such a heat pump might well be installed in a milk distribution station, both the necessary refrigeration and hot water for washing bottles being provided by the same machine. The slightly higher capital cost required for a compressor discharge temperature higher than that appropriate to refrigeration alone will very soon be paid for by the difference between the cost of heating the hot water directly and the cost of the small increase in electricity consumption by the refrigeration system when used in this way.

When only natural sources of low-grade heat are available and the resulting values of p.e.r. are about 3·0, the heat pump can only compete successfully with the direct use of electricity or gas under present conditions if amenity is given no value. Should the prices of coal and oil continue to rise, however, the heat pump will show an ever-increasing economic advantage, as electricity generation becomes more efficient and more and more use is made of nuclear energy. When higher temperature sources such as industrial waste heat can be utilized with values of p.e.r. of about 5·0 or 6·0, the capital cost of the heat pump will be paid back in, say, ten years, even in comparison with coal and oil at present prices.

Widespread application of domestic heat pumps will probably depend on the success of interested manufacturers in developing a package unit with a heating capacity of 10 kW at a price of the order of £250, excluding the heat-distribution system. This is based on air as a source of low-grade heat and an expected p.e.r. of 3·0. Local Authority housing, however, constitutes the bulk of potential demand. This demand would probably be satisfied by units constructed to heat one room only, with an output of the order of 3 kW.

Table 2. Some British Heat Pumps. Details of Operation and Construction

Location	Type of building heated	Maximum output rating	Driving power	Type of drive	Source of low-grade heat	Method of heat distribution	Maximum p.e.r. (allowing for auxiliary power)
		kW	kW				
Norwich	Office block	135	45	Electric motor	R. Wensum	Radiators and ceiling heating	3·0
Westwood Quarries	Underground galleries	51·3	13·8	Electric motor	Quarry air	Air conditioning	3·2
Stourport, Worcs.	Generating station offices	97	25·5	Electric motor	Generating station cooling-water outfall to river	Ceiling and floor panels	3·3
Stourport, Worcs.	Workshops	220	41	Electric motor	Generating station cooling-water outfall to river	Plenum warm air system	4·8
Meaford, Staffs.	Generating station offices	135	24	Electric motor	Generating station condenser water—bypass on flow pipe to cooling towers	Ceiling and floor panels	5·2
Cowes, I.W.	Office block	67	20·7	Electric motor	Generating station cooling-water outfall to river	Floor heating	2·9
Great Yarmouth	Office block	490	112	Electric motor	Generating station cooling-water outfall to river	Floor heating	3·8
Shinfield, Berks	Laboratory	28	7·5	Electric motor	Soil	Panel radiators	3·4
London*	Royal Festival Hall	2 700	525	Gas engine	R. Thames near Hungerford Bridge—plus engine waste heat	Radiators	3·0
Birmingham	Commercial building	23·5	6·75	Diesel engine	Canal water plus engine waste heat	Radiators	3·5
At sea	Survey ship	221	61	Diesel engine	Sea water plus main engine waste heat	Air conditioning	3·7
At sea	Passenger ship	2 700	660	Electric motor	Sea water plus main engine waste heat	Warm air	3·5
Oxford†	College building	147	37	Electric motor	City sewage	Ceiling and floor panels	4·0

* No longer operating. † Projected.

Industrial Management for Professional Engineers

5. MANAGEMENT AND EFFICIENCY *by C. C. Birch*

Previous articles in this series, published in the four preceding issues of the Journal, have touched on the subject of efficiency. The author's purpose in this article is to consider in more detail the tasks of a manager striving for efficiency. Mr. Birch is Production Director of Guest, Keen and Nettlefolds (Midlands).

I SHALL assume from the start that it is a manager's duty and desire to make the enterprise for which he is responsible ever more efficient and effective. There are many reasons why he should do so—such as the United Kingdom's desperate need for higher productivity, the need to make a profit, the fact that the whole enterprise may otherwise go bankrupt (not a bad reason in itself), and that no manager worth his salt can achieve any personal satisfaction if the job for which he is responsible is not running well and effectively—but these reasons are side issues to us now.

In considering the actions which a manager must take to encourage efficiency in his enterprise, I shall approach the problem from the viewpoint of a General Manager in a manufacturing firm who, for one reason or another, is beginning to take steps to improve the effectiveness of his company. Naturally the different conditions in, say, an oil refinery or a shipyard would change the emphasis on the factors discussed, but the main requirements leading to efficiency in business and industry would be unchanged. These main requirements are quite simple: first, a manager must know what he is trying to do, and must explain his policies and requirements to all his subordinates; secondly, he must give clear instructions; and thirdly, he must regularly, consistently and relatively frequently, check that his policies are being followed and that what he wants doing is being done satisfactorily.

All the activities of a manager spring from these basic principles—knowing what is to be done, directing it to be done, and checking that it is done. Quite obviously, in deciding what is to be done, a manager must have ascertained or formulated what his objectives or policies are, and these policies must be constantly under review: they cannot be settled once and for all, but must be kept up to date and changed when necessary. Then, having his aims, a manager must decide what is to be done to achieve them, and to make up his mind he uses many of the aids, reports and methods which assist him to check later that the necessary work has been carried out. He will consider what human resources he has available; what material and financial resources he has; what improvements are needed; what his competitors and other companies are doing; and what is happening both internationally and within his own nation. Later, in checking up on the work done, he will require statistics, he will observe personally both his own works and the works of other companies, and he will be constantly reviewing his various resources. He will also have to observe national and international events, to ensure that his aims and achievements are judged relative to the best contemporary standards.

In all our enterprises there is one common factor, which is that they involve human beings. In striving for efficiency, every manager is aided or resisted by men and women and it is only through them that he can achieve his aims. So it follows that the very first step our manager must take is to review his human resources. From his own experience (or failing that from reading previous articles in this series!) our manager knows clearly that he cannot do all the work himself or know all the answers. He must delegate or bust, and the quality of the individuals to whom he delegates affects all his work thereafter. It would be pleasant to assume that the right people are available as his delegates; that the desirable blend of youthful enthusiasm and elder wisdom, of technical knowledge and practical experience, is available; and, above all, that there are people who, by proving themselves adequate in platoons and companies, have won the right to lead battalions.

But it is quite likely that his firm is deficient in these respects and that something must be done to strengthen and balance the team if efficiency is to be gained. So he asks his personnel chief to make a record of members of the company who are qualified in any respect, or who are striving for qualifications, making particular note of those studying in their own time. He may be surprised at what emerges. Then he requests his subordinates to review annually, in an organized manner, the staff under their control, and this may also be fruitful. And so he learns what his strengths and weaknesses are, what faults and undesirable traits must be eradicated, where he needs to bolster or thin the ranks, where he is forced to recruit from outside, what promotions are necessary, and what training he must institute. He may also learn that some dismissals are necessary, or that some people have to be generously and humanely rested. Then he will ask the personnel chief to provide him with some statistics, on labour turnover for comparable levels of skill, output of training schemes, intake of new employees, which may well give an indication of the state of human relations in different areas of his company relative to each other and relative to other companies.

Then the manager must review his material and financial resources, his products and his markets, and the trend of development in his industry. He will in this manner be able to define clearly and exactly what are his long-term aims and what he wants his subordinates to do, now and in the future. This is his first step in the process of making his works efficient.

Having considered his resources and aims, the manager must set about making his management team effective. He will brief jointly—and, in more detail, separately—a very limited number of top officials in the main fields of endeavour. Their number must be kept small since each of these individuals will be consulting with him at regular or frequent intervals throughout the year, and, if too many are included at the first level of delegation, there will be inadequate time to deal with them thoroughly later. To each of these individuals he stresses that they in turn must summon their senior eight or ten people and repeat the process of passing on information. Additionally, if he is wise, he confirms all the points discussed in writing, and ensures a wide circulation of his intentions.

What are the points the manager must try to cover? To begin with, he must try to give a clear picture of the company's objectives and basic aims; secondly, he must define as sharply and accurately as he can the exact responsibility of each top official and the degree of authority he can exercise; thirdly, he must explain the relationship of each one to the other and of each main field to the other, and, in this connection, must give each an organization chart which is both logical and understandable. In more detail he will discuss with each how the aims and plans are to be implemented, and finally will explain that results are going to be checked carefully from now on and that incentives (appropriate to level) will be applied to those who really make progress.

He must next determine how he is going to control the work being done and how he will check that it is being done satisfactorily. His greatest aid in controlling and checking will be properly prepared and correctly chosen statistics, for with these he can measure the progress of the activities for which he is responsible. Statistics for management control purposes are viewed with great suspicion by many members of British management, particularly by managers on the shop floor. *The Economist* a few years ago drew attention to this fear of figures and suggested that, in many cases, it is the mark of the manager who is not confident in his own efficiency. The article went on to emphasize the very much greater use made by American industry of operating statistics, to the benefit of American efficiency, and underlined also the attention given to slick office organization in presenting useful figures with a minimum of staff to do it. Many readers will have heard these comments: 'These figures cost a lot of money and seem to serve no useful purpose'. 'I am not interested in history; the future is what concerns me'. 'Getting all these figures out delays production; it doesn't help it'. The motive behind many such comments may well be that suggested by *The Economist*, although it is true that figures not promptly available are largely a waste of time. Suspicion of the conclusions drawn from figures is another matter entirely, however, and the inquiring mind should always be encouraged, since unrepresentative figures badly presented can cause some very odd conclusions to be drawn. If the conclusions drawn are wrong, much harm can be done, and the system, instead of operating to improve efficiency, will act as a strong discouragement because it is unfair.

To illustrate the point of the conclusions that can erroneously be drawn from statistics if certain other vital information is left out, Margaret Knight's article, 'Can Figures Lie?' (published in *The Listener*, 3rd May 1951), is most revealing. One excerpt, borrowed from Professor Vernon, reads:

> In any large school one would certainly find a correlation between the size of the pupils' feet and the speed of their handwriting, but there is certainly no direct causal relation here; having big feet does not cause you to write quickly. This is a typical case where two things are related through a common third factor, and the third factor in this case is obviously age; it is the oldest children who have the biggest feet and the oldest children who are the quickest writers.

What figures, then, does our manager instruct the accounts department and others to produce for his own and his subordinates' information? He will want to know accurately what his plant and machine capacity is. He must also know what his manufacturing programme is, in order to ensure that he has sufficient capacity to meet it, whilst still leaving adequate time for maintenance, experimentation (both mechanical and human), training, etc. Assuming that all is well in these respects—and we have blithely disposed of a big subject in a few words—how can the manager get to know from week to week how he is faring? How does he measure the trend of progress in his company? First, he must have regular statistics which show his output figures—if not by department or individual product, certainly by groups of departments and groups of products, dependent on the size of his empire. These figures should be shown on a graph so that he can see the trends quickly. The more detailed information must also be available at lower levels in the management chain so that, when the manager needs to probe in any direction, the facts and figures are immediately available.

Let us once again assume that all is well and that the quantities the sales department requires are being made and are available for delivery at the right time. How does the manager tell whether the products are consistently good? It is clear that he needs regular quality and performance test reports from his inspection and/or quality department, and a record of scrap made as a percentage of the output. He will also want a periodic report on his competitors' products in relation to his own, and an analysis of customers' complaints.

We have seen that the manager can check with the aid of records such matters as lateness and absenteeism, but, as these are not normally likely to be large, it is more important that he checks the effectiveness with which the time of his employees is spent when they are present.

Where incentive systems of any sort are operated (and they should be operated wherever practicable) he must have reports showing the amount of additional output such incentives have stimulated, and clearly he must be kept informed of work which should be based on an incentive but is not, for one reason or another. When talking of incentives, one customarily thinks of machine operators and kindred workers, but what, meanwhile, of the staff; is anyone measuring their output? Of course we do not expect the real thinker to be tied down to a target figure of useful thoughts, but how many of them are really thinking? Is it not true that many are routine workers for whom tasks could be set and performance against these tasks measured, and could they not, in many cases, have an incentive either in money or leisure, applied?

Then our manager must be given, in percentages, information on how the operating hours of plant are occupied and, in absolute terms, he must have information on his stocks of raw material, work in process, and finished goods. Finally he must have information on the complicated and dreaded subject of cost. This is because many of the activities in a company can be conveniently measured and compared only when expressed in pounds, shillings and pence. Clearly I have already referred to a number of statistics having a bearing on cost (labour costs, plant utilization, scrap, stocks, etc.), but our manager will find that he must have usable figures on costs for all his main areas of responsibility and that he must strive with might and main at all times to produce at the lowest possible operating cost.

The manager will find that, when all these necessary statistics have been collected, they constitute a formidable amount of reading, even if they are presented in the simplest form. Also, there are a number of other aspects of his job which I have not yet examined. The manager has had these statistics collected so that he can control and check the work done for him, and they must be made to help him. The figures have not been produced just for fun, to increase the staff and enrage the Chairman (who comments annually on the way the number of staff is creeping up), but to enable the manager to control his job. It has been established by practice over many years that he can best check if he investigates only matters which are deviating from a predetermined standard, and it is here that he exerts influence over his own efficiency. He can make the best use of his time if he 'controls by exception', i.e. if he spends his time examining work which has been done either better or worse than expected. In order to do this, he must each year allow time to decide what performance he can reasonably expect from each department for which he is responsible. He must set targets, and his statistics must show him quickly those activities which are below their targets and those which are above. These are the matters to which his attention should be directed, for, presuming the targets are fairly set, it can be assumed that those things which achieve the targets are running satisfactorily. So our manager must decide at an early stage what he can reasonably expect the figures to be, and he has got to set, in conjunction with sales, engineering, manufacturing and cost departments, departmental managers, etc., targets or budgets which are thought to be attainable under the prevailing conditions. It is most important that these targets should be set at a high level, although they must, of course, be agreed as attainable by those responsible for achieving them. The manager will find the time spent on setting and getting agreement to these standards well spent, because the use of them will free many hours for him later on.

Next the manager must satisfy himself that the targets set are reasonable ones, and in this respect he cannot usually rely on internal knowledge alone. He must have yardsticks against which to measure himself. This is quite vital, and he must endeavour to have a yardstick by which to judge himself for every portion of his work. To some extent he may be able to do a little with the information already mentioned, in that, where he has two departments doing similar work or similar operations, one may emerge as better than the other. He can then ask why the performance in this 'better' department cannot be emulated in the other. But, much more important, he must know what is going on outside. If his vital control statistics have been prepared as they should be, so that, in a very short time each week, he can see where his attention must be directed, he will have time to find this out.

But how does he set about it? Much depends on the type of business he is in and how many companies are in it. To begin with he can cull quite a lot of information from the technical Press appropriate to his product, and, even if he cannot find time—as is the case with so many of us—to read technical literature, he should have someone within his organization taking digests of the more important relevant articles. Secondly he must 'get about'. This phrase, which covers a multitude of sins and involves, in the minds of a great many people, merely eating and drinking at the company's expense, should actually mean the constant exercise of an eagle eye at other companies he visits within and without his own trade. It is possible to learn something from every other company, even if it is only how not to do a job. Our manager must ensure that some portion of his time is spent on visiting carefully selected manufacturing organizations, which need not necessarily be in the same industry as his own.

Other most useful sources of information for the manager are the manufacturers of the plant, machinery and equipment he operates, for they have experience of the performance of the plant elsewhere. He can also acquire much useful information from his own and his staff's membership of professional institutions which provide regular information on performances and activities elsewhere, and by visiting exhibitions and conferences. Thus the manager can gain knowledge which he can use to judge his internally set targets to see whether they are sufficiently high.

Now, besides having had to learn to read faster to encompass the information previously mentioned, the

manager must always allow himself time to check personally the activities within his company and to deal with important matters such as trade unions. He must walk around his workshops, offices and factories, and he must use his observation and knowledge of technical matters in judging whether work is being performed competently. His personal observation, coupled with the judicious use of statistics and figures, is the only sound way of checking that the work he wants doing is being done satisfactorily. He can also in this way contribute greatly to efficiency in his company by stimulating good morale as a result of his constant interest in, and knowledge of, what is going on, as a result of regular and frequent contact with the people under him and by maintaining an interest in people who are really trying. He can in this way always be gathering information and, in effect, carrying on perpetual consultation with many levels of employees, rather than only encountering shop stewards at meetings, and never meeting a foreman as is so often the case. He must take great care, however, that he does not usurp the authority of subordinate supervisors or managers and, if not accompanied by the supervisors concerned on his tours, he should at least acquaint them of his presence in their departments.

There is a further danger which the technical man who has become a manager must guard against during his contacts with his technical subordinates. He must reconcile himself to spending comparatively little time on technicalities and to spending most of his time on managerial and administrative duties. Furthermore, he must avoid spending a great deal of time 'putting the job to rights' whenever a problem involving his own special technical knowledge comes up. Hours can be wasted in this way. This is perhaps not a bad thing, if it is occasional, inasmuch as some mutual respect may arise from it; but very occasional it must be. If, in fact, the manager cannot resist indulging in lengthy technical discussions with the people he has employed to do such things and to whom the work has been delegated, then he should have stayed as a designer, chemist, development or plant engineer, and not have been promoted to manager.

I have examined ways in which a manager can improve efficiency in his company by deciding what needs to be done and by checking that it is done satisfactorily. As yet no emphasis has been placed on what is to most people the obvious way in which efficiency can be improved—that is by installing new plant and equipment. It is my experience that very great increases in efficiency can be gained by intensive examination and improvement of existing methods and administration without the added expense of new equipment. If our manager has clearly specified what he wants and has developed good rapid methods of checking that the work is done well, then he will have arranged his working time so that he has opportunity to look for ways of improving the effectiveness of his organization. We know that a company reflects the attitude of its highest managers. If the man at the top is constantly spurring himself and his subordinates to greater efforts and is constantly checking not only their performance but also his own performance *vis-à-vis* other companies, there will automatically be increased efficiency within his company. It is only when the right attitude is instilled that such valuable devices as a work study department, hiring consultants, or setting up one's own organization and methods department can reap their full harvest.

In summary, then, the constant aim of the manager must be for greater and greater efficiency in all departments of his company. He can achieve this by:

(*a*) deciding his aims and objectives or policies,
(*b*) deciding what he wants done to achieve these aims,
(*c*) issuing clear directives to his subordinates, and
(*d*) checking that his subordinates carry out his directives.

We know that to do this the manager must marshal his resources in such a way that they can be used effectively. Quite obviously the first step he must take is to make his humans effective and to give them a framework within which they can work efficiently, without either killing themselves or wasting time. Then he has got to formulate targets or standards by reference to internal and outside sources of information and his own experience. These targets he will incorporate in his systems of measurement so that he can save time by investigating exceptions and by observing trends. And finally he has to visit his own people and other companies so that he is constantly aware of what is going on.

Two girls being instructed in sheet metal work at the apprentice training school of a large electrical engineering firm. In April this firm held an Easter Vacation Course for schoolboys and schoolgirls from public and grammar schools. More than forty attended the week's course, half of each day being spent in the training school and the other half in visiting manufacturing departments and laboratories.

ANNUAL REPORT FOR 1956-57

Report of the Council presented at the Annual General Meeting on the 23rd May 1957

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SECTION B Institution Activities
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Introduction

At the Eighty-Fifth Annual General Meeting of The Institution the Council present their Report for the year ended 31st March 1957.

The membership of The Institution continues to grow, and a record number of applications was received during the year. The total now exceeds 41 000, of whom more than 22 000 are Corporate Members.

The revised Bye-laws were allowed by the Privy Council on the 3rd August 1956; the consequent changes in subscription rates took effect on 1st January 1957.

Three very successful Conventions have been held on 'Digital Computer Techniques', 'Ferrites', and 'The Electrical Equipment of Aircraft', each of which was attended by many visitors from oversea, and a Convention on Microwave Valves is being planned for 1958.

The Council set up a Study Committee to see whether the present structure of Local Centres and Sub-Centres was such as to provide members in the provinces with the best possible services both now and in the foreseeable future. Their report is under consideration by the General Purposes and Local Centres Committees of the Council.

The *Journal* is still very favourably received. A number of minor changes have been progressively introduced and next year it is hoped through a special inquiry to ascertain the most appreciated items, and to obtain suggestions for further improvements.

The Government's Report on Scientific and Engineering Manpower in Great Britain has been carefully studied by the Council. Measures to stimulate recruitment to the electrical engineering profession have been continued, and attention is now being focused on the recruitment of girls as well as of boys, to meet the country's needs for professional engineers.

The work of the National Council for Technological Awards has been followed with interest; its award for engineering studies will be designated 'Dip.Tech.(Eng.)' to distinguish it from 'Dip.Tech.', the award which applies to other technologies, a decision greatly welcomed by Council.

Arrangements have been made for the formal opening of the new Electrical Power Collection at the Science Museum on the afternoon of the 20th May 1957. The Rt. Hon. the Viscount Hailsham, P.C., Q.C., Minister of Education, will perform the ceremony.

In September 1956 a team concerned with engineering education nominated by the three senior engineering institutions and including representatives of The Institution visited the Soviet Union. Their report was presented at a Joint Meeting of the three Institutions. A corresponding Russian team paid a return visit to this country at the end of October 1956. Another team, sponsored by The Institution of Civil Engineers with Sir John Hacking, Past-President, as leader, visited the Soviet Union in September 1956 to study hydro-electric engineering developments. The report of this team will be presented at a Joint Meeting of the three senior Engineering Institutions to be held at The Institution of Civil Engineers.

The Oversea Branches, Oversea Committees and Joint Oversea Groups have continued to provide meeting facilities for members oversea and opportunities to discuss Institution and locally sponsored papers. Several senior members whose duties took them abroad very kindly addressed meetings while away; opportunities for this kind of direct contact with The Institution at home are much welcomed by oversea members, and senior members who are going abroad are urged to communicate with the Secretary in good time before their journey if they are prepared to act in this way.

In concluding this Introduction the Council record their sincere appreciation of the services performed for The Institution by the Honorary Officers at home and oversea, and express their thanks to them and to the many other members who give of their time so loyally and ungrudgingly in the interests of The Institution.

SECTION A Membership

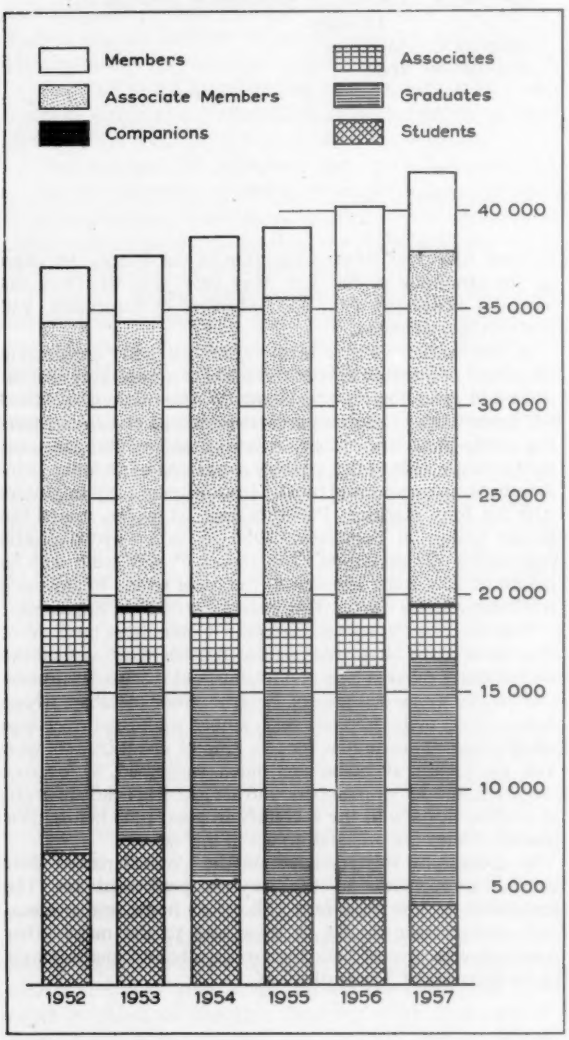
1 The Register

The record number of 5745 applications for election or transfer were dealt with during the year. The number in

1955–56 was 4814, the previous highest total of 5282 having been attained in 1948–49. The number of members elected during the year was 2681, compared with 1978 in 1955–56.

On the 1st April 1957 there were 34733 Corporate Members and Graduates on the Register, representing 83·65% of the total membership of 41522. The total number of Corporate Members now exceeds 22000 and the number of Graduates increased during the year to 12652 (11797 in 1955–56). The number of Associate Members who have transferred to the class of Members again compares favourably with previous years.

Two women were admitted to Associate Membership during the year, bringing the number of women in that class to 28, the total for all classes of membership being 72.



1 *Growth of membership*

2 Honorary Members

The Council take great pleasure in recording that they have elected Sir Noel Ashbridge, B.SC.(ENG.), Past-President, to Honorary Membership of The Institution in recognition of his distinguished services to The Institution and his outstanding contributions in the field of radio engineering, particularly in the development of the British sound and television broadcasting services.

Under the powers conferred on them by Bye-law 10, the Council have this year elected an additional Honorary Member, Brigadier-General Sir Harold Hartley, G.C.V.O., C.B.E., M.C., M.A., F.R.S., in recognition of his life-long interest in all aspects of engineering science, and for his studies of the conservation of natural resources.

3 Faraday Medal

The thirty-fifth award of the Faraday Medal has been made to Dr. Waldemar Borgquist, lately President of the Swedish State Power Board, for his outstanding contributions to the development of electricity supply and transmission, particularly at extra-high voltages, and for his long-standing interest in the education and training of engineers.

4 Principal Honours and Distinctions conferred on Members

Order of Merit

Cockcroft, Sir John D., K.C.B., C.B.E., M.A., D.SC., M.SC.TECH., PH.D., F.R.S. (*Member*).

Knight Bachelor

Dean, J. N. (*Companion*).
Eccles, J., C.B.E., D.SC. (*Member*).

Knight Commander of the Order of the Bath

Radley, Sir Gordon, C.B.E., PH.D.(ENG.) (*Member*).

Companion of the Order of the Bath

Anderson, J., C.B.E. (*Member*).

Knight Commander of the Order of Saint Michael and Saint George

Angwin, Colonel Sir A. Stanley, K.B.E., D.S.O., M.C., T.D., D.SC.(ENG.) (*Hon. Member*).

Companion of the Order of Saint Michael and Saint George

Halsey, R. J., B.SC.(ENG.) (*Member*).

Commander of the Order of the British Empire

Bedford, L. H., O.B.E., M.A., B.SC.(ENG.) (*Member*).
Fulton, A. A., B.SC. (*Member*).
Humphreys, O. W., B.SC. (*Member*).
Owen, J. McA. (*Member*).
Peattie, J. D., B.SC. (*Member*).

Officer of the Order of the British Empire

Alder, C. D., B.SC. (*Associate Member*).
Britton, C. A., M.ENG. (*Member*).
Cormack, J., B.SC. (*Member*).
Golding, E. W., M.SC.TECH. (*Member*).
Heys, C., B.SC.(ENG.) (*Member*).
Hitch, Lieut.-Col. F. A. N., R.A. (*Associate Member*).
Horn, C. O., B.SC. (*Member*).
Hough, F. A., M.SC.(ENG.) (*Associate Member*).
Howe, A. B., M.SC. (*Associate Member*).
James, E. G., B.SC., PH.D. (*Associate Member*).
Jofeh, M. L. (*Associate Member*).
Jolley, E. H. (*Member*).
McCarthy, Lt.-Col. D. W. C., M.B.E., M.A., R.E. (*Associate Member*).
McKearney, P. (*Member*).
Midgley, H., M.Sc. (*Member*).
Roche, A. H., B.SC.(ENG.) (*Associate Member*).
Roots, A. E. (*Member*).

Member of the Order of the British Empire

Aked, J. A. (*Member*).
Collins, A., B.SC.(ENG.) (*Member*).
Starr, H. (*Associate Member*).
Warren, W. (*Member*).
Webbe, Captain D. B., R.E. (*Associate Member*).

Imperial Service Order

Wells, R. I., B.SC.(ENG.) (*Member*).
Woolfall, R. (*Associate Member*).

Clasp to Territorial Efficiency Decoration

Solomon, Major T. H., T.D., B.SC.(ENG.) (*Member*).

Emergency Reserve Decoration

Beattie, M. H. (*Member*).
Rata, S., B.SC.(ENG.) (*Associate Member*).
Wearn, Major R. G. O., M.B.E., R. SIGNALS (*Associate Member*).

5 Deaths

The Council record with regret the deaths of the following members of The Institution:

Honorary Member

Hunter, P. V., C.B.E.

Members

Anderson, A. M.
Anderson, F. C.
Andrews, L., M.B.E.
Atkinson, R. C.
Bainbridge-Bell, L. H., M.C., M.A.
Bennett, C. G. M.
Best, F. L.
Burrowes, R. B., B.SC.
Carrothers, C. G., B.ENG.
Chapman, W. H.
Chaytor, A. R.
Clough, F. H., C.B.E.
Collins, F. A.
Collis, A. G.
Combe, L. H.
Cozens-Hardy, The Rt. Hon. Lord.
Ede, S. S. M.
Edwards, J. H
Evans, E. J., M.SC.(ENG.).
Faber, O., C.B.E., D.SC.
Fippard, A. J.
Gearing, W. S.
Gilbert, A. B.
Glendenning, Lt.-Col. S. E., D.S.O., T.D., R.E.
Goad, Major D., O.B.E.
Hackworth, W. R.
Hall, F. T.
Hamlin, E. J., D.SC.
Hammett, M. G.
Harper, H. R.
Harvey, H. B.
Hawes, G. W. S., O.B.E.
Heath, R.
Hettinger, J., PH.D.
Higgs, E. P., B.SC.(ENG.).
Hippisley, Comdr. R. J. B., C.B.E.
Horrell, L. L.
Im Thurn, Vice-Admiral J. K., C.B., C.M.G., C.B.E., R.N.
Kelly, A. C.
Laborde, M. E., ING.E.S.E., L.ÉS.SC.
Laidlaw, E. A.
Law, A. H.
Leaf, E. H.
Lee, J. A.
Lees, J. B.
Leys, G. D.
McDonald, Col. A. G., O.B.E., B.SC.(ENG.), R.E.M.E.
Main, F. W.
Meacher, W.
Midgley, H. E.
Mitton, F. E.
Mold, L. E., O.B.E.
Morris, A. T.
Mountain, K. A.
Muirhead, A. B.
Neale, E. P.
Okell, E. G.
Phillips, Air Commodore R. L., C.B., C.B.E.
Phillips, R. W. L.
Pilditch, G. F.
Plowman, R. C.
Rendell-Baker, F. N.
Richards, E. A., M.B.E., B.SC.
Riordan, E. J., B.E.
Robinson, J., D.SC., PH.D.
Rodger, J. W.
Ryan, A. J., M.B.E.
Saaler, J. W.
St. John, E. C.
Sayers, J., O.B.E.
Shilston, T. P., B.SC.
Silver, H. C.
Sinnott, J., O.B.E.
Sleeman, Col. H., T.D.
Smith, Gilbert.
Stockings, Lt.-Col. T., R.E.M.E.
Sulston, W. J., M.SC.
Taylor, W. T.
Timms, M. C.
Wadsworth, T., M.SC.
Walker, G. M.
Ward, F. M.
Weaver, R. A., O.B.E.
Wedmore, E. B., C.B.E.
Wells, H. C.
Whitehead, S., M.A., D.SC.
Wright, G. M., C.B.E., B.ENG.

Associate Members

Adam, H. A.
Allen, E. R.
Antram, A. H.
Baker, C. A.
Barber, B.
Barnett, E. B.
Baxter, E. H.
Bayspoole, R. F. H.
Beall, H. J.
Bell, A. M.
Bland, J. G.
Boyle, A. L.
Breeze, H. W.
Brierley, B. A.
Brock, J. F.
Bunning, R. H.
Butterley, A. D.
Butterworth, H.
Carter, E.
Caspard, C. C.
Catt, J. E.
Clark, W. E.
Clarkson, G. W.
Clegg, G. D.
Clyne, P.
Cobham, G. F.
Colquhoun, J. B.
Cook, F. A.
Cooper, R. G.
Court, P. A., B.SC.(ENG.).
Cox-King, F. H.
Creasey, R. C.
Davies, B.
Dickinson, J. C.
Dunn, R. H., B.SC.
Ellinger, W. A.
Ellis, J. R.
Ennos, J. F., B.SC.(ENG.).
Entwistle, J.
Fairbairn, V., B.E.
Farrar, F.
Field, S. W.
Fleming, J. G., M.SC.
Fletcher, J. R.
Foden, A. M., B.SC.TECH.
Fortuyn, D., B.SC.(ENG.).
France, W.
Fry, J. A., M.ENG., B.SC.
Gill, P. L.
Graty, T. R , M.C.
Gray, W.
Habgood, E. V. C.
Hackett, D. A.
Hall, E.
Hall, F. C.
Hart, H. E. W.
Heaney, J. W.
Henderson, J., B.SC.(ENG.).
Herring, H. R.
Hibell, A. R.
Hoare, E. S., M.C., B.SC.
Holdsworth, M.
Holtham, A. E. J., PH.D., B.SC. (ENG.).
Hopkins, C. J.
Hopkinson, A. F.
Hyde, H.
Hyland, J. G. H.
Inman, O.
James, C.
Jenkins, H. B.
Jones, M. C.
Kay, E. W.
Knighton, C. W.
Langdon, G. H.
Langshaw, W. G.
Laws, W., B.SC.
Lawson, R.
Lief, F. L., B.SC.
Lloyd-Jones, G.
Macan, R.
McCloy, J. W., B.SC.
McGillivray, J.
Mackay, J. E.
McKeown, C. H.
Martin, E. M.
Morrill, A. E., B.SC.(ENG.).
Morris, E. R.
Mott, J. E.
Ogilvie, A. M., B.SC.
Omar, S., B.SC.(ENG.).
Parsons, R. A.
Penny, R. W.
Petrides, S. A., B.SC.TECH.
Plumtree, J. S.
Pond, T. A.
Poole, R. T.
Powell, H. H.
Price, H.
Price, T. W.
Read, R. C.
Richard, D. M., B.SC.
Ripley, H. P.
Robson, W. T., M.B.E.
Rodgers, H. N.
Rothwell, A.
Rothwell, E.
Savage, J.
Scholefield, P. W.
Shaw, R.
Smith, P. E.
Smith, T.
Stone, N. P.
Sutcliffe, T. H., B.SC.TECH.
Sutton, G. P.
Taylor, J. A.
Terry, R. S. G., B.SC.(ENG.).
Tewsley, E. N.
Thalis, K. G. V.
Thomas-Davies, G.
Vincent, J. J.
Walker, J.
Walmsley, Captain A. R.
Walter, W. G.
Ward, C. A.
Warren, S. N.
Weir, W.
West, S. B.
Wilbraham, E. A.
Wittey, P. O.
Wyman, H. L. D.

Companions

Haslett, Dame Caroline H., D.B.E., J.P.
McGill, W.

Associates

Abbott, E. R.
Ashmore, D. S.
Ashton, W. H.
Bailey, F.
Barlow, A. L.
Churchill, C. H.
Felix-Smith, L. E.
Foinette, Lt.-Col. T. W.
Hauser, F. V.
Hennen, E. S. S.
Holt-Keene, H.
Hooper, J. F. W.

Associates—continued

Jones, C. E. P.	Robertson, N. C., C.M.G., M.B.E.
Kelley, W. R. W.	Shackleton, H. A.
MacGillivray, E. D.	Shuttleworth, H.
Mackie, Lt.-Col. E. G.	Stancer, G. H.
Marston, G. W.	Stevenson, C. L.
Morris, A. A.	Sutcliffe, J. H.
Ogden, Major H. W. R., E.R.D., R.E.	Thomson, C. E.
	Watson, L. H.
Pickering, J. K.	White, W.
Roberts, T. J.	

Graduates

Ambler, M.	Gove, C. W.
Bowley, W. D.	Lorimer, J. A.
Fellows, I. R.	Saunders, R. A.
Ferguson, W. A., B.SC.(ENG.).	Williams, A. L., B.SC.(ENG.).

Students

Ainscough, J.	Myers, B.
Dolbear, A. E.	

6 Members who have Retired, or who are of Long Standing

During the year, 196 members took advantage of a rule under which Members, Associate Members and Associates who have retired from the profession may apply to retain their membership without payment of further subscriptions, provided that they have reached the age of 60 and have had 25 years' continuous membership. A comparable rule applies to Companions, who must have reached the age of 70.

Sixty-one members qualified for a total remission of subscription under a rule covering members of any class who have completed 50 years' membership.

7 The Designation 'Chartered Electrical Engineer'

The Council's emphasis on the desirability of a wider use of the title 'Chartered Electrical Engineer' was marked by the inclusion in the *Journal* for November 1956 of a Foreword entitled 'Chartered', which aroused considerable interest.

Diplomas of Corporate Membership now include the designation.

8 Professional Conduct

Acting under the proviso to Bye-law 42 (iii), the Council have authorized the members of a firm of Consulting Engineers practising in Canada, who are members of The Institution, to conform there to the practices set out in the Code of Ethics of The Engineering Institute of Canada. They have also authorized a Corporate Member who practises as a Consultant in Argentina to publish in that country a professional card in the manner customary in the Americas.

9 Unauthorized Use of Membership Initials

During 1956, in response to the firm action which the Council take in such cases, satisfactory undertakings and apologies have been received from seven offenders for making unauthorized use of designations of Institution membership.

The Council will be glad if members will bring the facts of any doubtful cases to the attention of the Secretary.

10 Bye-law Revisions

Allowance of the Bye-law revisions approved at the Special General Meeting held on the 22nd March 1956, was signified by the Lords of Her Majesty's Privy Council on the 3rd August 1956. The revised subscription rates comprised in these changes came into force on the 1st January 1957. Details of the changes appeared in the *Journal* for October 1956.

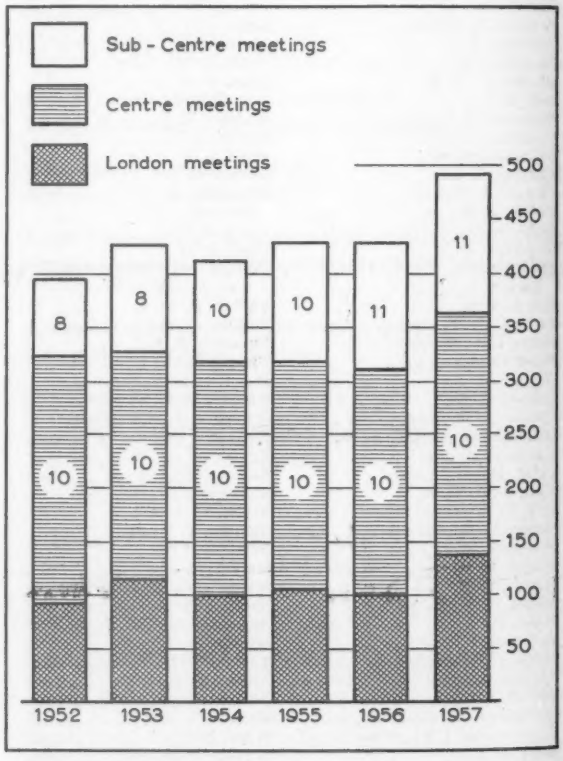
SECTION B Institution Activities

11 Meetings

During the 12 months ended the 31st March 1957, 1365 meetings of the members, the Council and the various Committees were held in London and at the Local Centres, an increase of over 100 compared with the figure for 1955–56. A detailed statement is given in Appendix C, and Fig. 2 shows the number of meetings held during the past six years.

Twelve Ordinary Meetings were held in London, with an average attendance of 290. Of these, one was a joint meeting, linked by the Transatlantic Telephone Cable, with the American Institute of Electrical Engineers and the Engineering Institute of Canada at which the engineering of the cable project was reported and discussed. In addition, the Annual General Meeting and two joint meetings with The Institutions of Civil and of Mechanical Engineers were held.

The Second Graham Clark Lecture, arranged by The Institution of Mechanical Engineers, was delivered in April 1956 by Sir Maurice Bowra, F.B.A., M.A., on 'The Impact of Engineering on Society'. The Institution arranged the Third



2 *Total number of Meetings held in London and in the Centres and Sub-Centres*

The numerals 8, 10 and 11 indicate the number of Centres and Sub-Centres.

Graham Clark Lecture which was given, in February 1957, by Sir Ifor Evans, M.A., on 'The Place of Engineering in University Education'.

A public meeting was held at the Central Hall, Westminster, London, for the delivery of the 1956–57 Faraday Lecture by Dr. T. E. Allibone, D.SC., F.R.S., MEMBER (see par. 21).

The 47th Kelvin Lecture on 'Radio Astronomy' was given by Professor A. C. B. Lovell, O.B.E., PH.D., F.R.S.

Reference to the meetings of the four Specialized Sections and the Informal Meetings of The Institution will be found in subsequent paragraphs.

12 Specialized Sections

The work of the Specialized Sections continues to increase and there has been a corresponding increase in membership, as will be seen from Fig. 3. The following statement shows the membership of the Sections, the number of meetings that have been held and the average attendances.

	Membership at 31st March, 1957	Number of meetings	Average attendance (figures for last year in brackets)
Measurement and Control	2825	15	71 (61)
Radio and Telecommunication	5419	14	197 (152)
Supply	4976	9	141 (147)
Utilization	4367	8	115 (120)

Measurement and Control Section

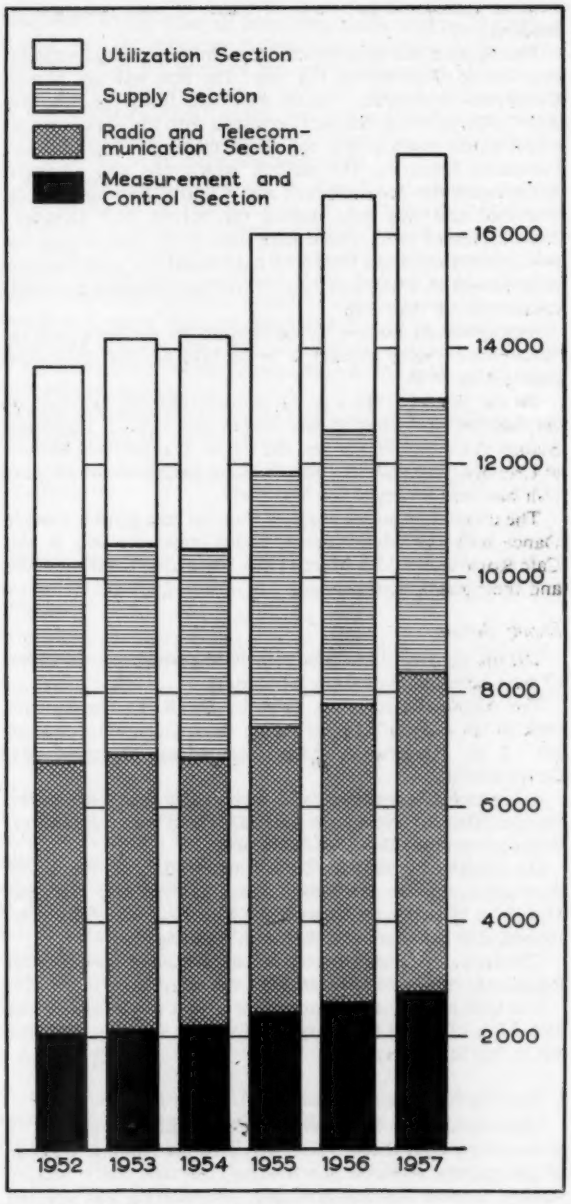
A Convention on Digital Computers, arranged in collaboration with the Committee of the Radio and Telecommunication Section and the D.S.I.R. Advisory Committee on High Speed Calculating Machines, was opened on the 9th April 1956 by Sir George Nelson, BART., the then President of The Institution, when an Opening Address by Sir Cyril Hinshelwood, M.A., D.SC., F.R.S., and an Introductory Lecture by Professor F. C. Williams, O.B.E., D.SC., D.PHIL., F.R.S., MEMBER, were delivered. Subsequently 74 lectures, papers, and other contributions were presented at 17 sessions and attendances of 7406 were recorded. It is significant that of the 1423 registrations for the Convention, one-half were received from non-members, accounted for by the large number of mathematicians and physicists who attended, and by 127 visitors from oversea. A reception to the authors and oversea visitors was held in the Library of The Institution on the opening evening, and the Convention concluded with visits to 35 typical computer installations. The Joint Organizing Committee has now been disbanded, but the general subject of computers has been entrusted to a Panel to deal with the many questions which continue to arise out of developments in these techniques (see also par. 33).

The Committee have considered 54 papers during the year; 10 were accepted for reading at meetings, and 13 of a specialist character, for publication only.

The Annual Lecture was delivered on the 8th May 1956 by Mr. J. Bell, M.SC., MEMBER, his subject being 'Ship Stabilization: Automatic Controls, Computed and in Practice'.

The Summer Visit took place on the 15th June 1956 when 82 members and their ladies visited the University Engineering Laboratory and the Applied Psychology Research Unit, Cambridge. Lunch was taken in Hall at St. John's College, and in the afternoon the party visited Ely, where they were conducted through the cathedral and entertained to tea.

The Section Dinner was held at the Café Royal, London, on the 13th November 1956. The principal guest was Sir Henry Tizard, G.C.B., D.SC., F.R.S., and the company present numbered 269. The Section again joined with the Radio and Telecommunication Section in a Dinner-Dance (see below).



3 *Membership of the Specialized Sections*

Radio and Telecommunication Section

The programme comprised, in addition to the Opening Meeting, seven Section Meetings devoted to the presentation of papers and six Informal Evenings.

One hundred and twenty-nine papers have been submitted to the Committee for consideration, an increase of 21 on the

number considered last year. Of these, 11 were accepted for reading.

The Section has been concerned with the arrangements for two Conventions during the year. The first was on 'Digital Computer Techniques', which was held from the 9th–14th April 1956, in which the Section joined with the Measurement and Control Section and the Department of Scientific and Industrial Research. The second, which was also arranged jointly with the Measurement and Control Section, was on 'Ferrites' and was held during the period 29th October–2nd November 1956. There were over 1 000 registrations for this Convention, and a total of 60 papers and oral contributions were presented. Delegates from 13 oversea countries attended, totalling more than 150.

Arrangements are now going forward for a Convention on 'Microwave Valves', which is to be held at The Institution during May 1958.

On the 7th July 1956 a party of more than 200 members of the Section and their guests visited the B.B.C. Television Station at Crystal Palace and the I.T.A. Transmitting Station at Croydon. The visit was heavily oversubscribed and a repeat visit has been arranged for May 1957.

The concluding social event of the year was a Joint Dinner Dance with the Measurement and Control Section at the Café Royal on the 15th March 1957, when about 300 members and their guests were present.

Supply Section

During the year 32 papers have been considered. Of these, 17 were accepted, 6 of them for reading.

The Annual Lecture was given by Dr. R. L. Hearn, who took as his subject 'The Sir Adam Beck Generating Station No. 2 at Niagara—A Major Canadian Hydro-Electric Development'.

A total of 192 members and their ladies took part in the Section Visit to Northern Ireland, which was centred on Belfast, from the 6th to 9th September.

On the 5th May 1956 a visit was arranged to the Houses of Parliament, and to the Royal Naval College and National Maritime Museum at Greenwich. The visit was fully subscribed, 240 members and their ladies taking part.

The Section Annual Dinner-Dance was held at the Criterion Restaurant on the 5th March 1957, the attendance being 327.

The Committee have arranged for a visit to Oxford on the 25th May 1957 and for a week-end visit to Belgium from the 5th to 9th September 1957.

Utilization Section

From a total of 25 papers submitted during the year 19 were accepted; of those, 9 were accepted for reading. Because of the papers available for reading, the customary Section Annual Lecture was not arranged; one meeting was devoted to the reading of 3 short papers by Graduate members.

A Convention opened by the Minister of Supply, the Rt. Hon. Reginald Maudling, M.P., on 'Electrical Equipment of Aircraft' was held from the 2nd to 4th May 1956, at which 19 papers were presented. Attendance at the six Sessions ranged from 280 to 516 persons with an overall average of 396. Registrations were accepted from 396 members of The Institution and 368 non-members. A special supplement to the *Proceedings*, Part A, was produced to cover the Convention and was published in January 1957.

The Section Summer Visit, attended by 119 members and their ladies, was held at Harrogate from the 11th to 13th May 1956.

The Section Annual Dinner-Dance was held at the Café Royal on the 16th January 1957, and was attended by 176 members and their ladies.

13 Informal Meetings

Eight Informal Meetings were held during the year, and covered a wide range of subjects. These meetings give opportunities for the free and informal discussion of a range of topics wider in scope than is found in any other part of The Institution programme. In particular, they provide a means whereby the younger or more diffident members can gain experience in making their opinions known in public, thereby acquiring confidence to take part in discussions on papers read at Ordinary and Section Meetings.

The proceedings of the meetings are entirely informal, and no report is published.

14 Local Centres and Sub-Centres

During the year under review 534 meetings of a general character were held by the ten Local Centres, the eleven Sub-Centres and the eleven Specialized Groups. The Council regard this level of activity as very satisfactory and as reflecting great credit on the local committees concerned. 19169 members are attached to the ten Centres, the figures being as follows:

East Midland	1649	North-Western	3027
Mersey and North Wales	1355	Scottish	1819
North-Eastern	1451	South Midland	3520
Northern Ireland	325	Southern	1745
North Midland	1894	Western	2384

In addition to the General Meetings a number of social functions have been held, at many of which the President, accompanied by the Secretary, was present. The Vice-Presidents have visited all 21 Centres and Sub-Centres and they and the Honorary Treasurer have deputized for the President at a number of social functions which he was unable to attend.

During the year the Council requested the General Purposes Committee to set up a special Study Committee to examine the service which the present structure of Local Centres and Sub-Centres provides for members in the provinces, and to make recommendations for the future in the light of experience gained in operating the present system and having regard to the steadily increasing membership. The report of the Study Committee is now being considered by the General Purposes Committee and the Local Centres Committee of the Council, whose views have been sought before it is submitted to the Council for their consideration.

The following Honorary Secretaries of Centres and Sub-Centres have tendered their resignations during the year under review:

Dr. W. Alexander, M.SC.(ENG.), MEMBER, East Midland Centre, after one year of service.

Mr. J. W. Lynn, M.SC., ASSOCIATE MEMBER, Mersey and North Wales Centre, after two years of service.

Mr. A. T. Crawford, B.SC., ASSOCIATE MEMBER, North-Eastern Centre, after five years of service.

Mr. R. A. W. Connor, MEMBER, East Anglian Sub-Centre, after one year of service.

Mr. C. E. Smith, B.SC.(ENG.), ASSOCIATE MEMBER, North Lancashire Sub-Centre, after five years of service.

Mr. G. L. Doig, B.SC.(ENG.), ASSOCIATE MEMBER, North Scotland Sub-Centre, after three years of service.

The Council welcome this opportunity of recording their

sincere appreciation of the services these members have rendered to The Institution.

The interests of local members of the four Specialized Sections have been met wherever possible by the formation of Specialized Groups, of which there are now eleven. Several Groups were visited by their respective Section Chairmen.

15 District Meetings

The District Meetings which have been held in many places throughout the country where membership of The Institution is too small to justify the provision of meetings of a more formal type have continued to be extremely successful. Many members who would have little opportunity of attending other meetings of The Institution have expressed their appreciation of this facility. The work performed by the conveners of District Meetings is greatly appreciated by the Council.

16 Graduate and Student Sections

Two further Graduate and Student Sections have been formed during the year, one associated with the Irish Branch and the other with the Tees-Side Sub-Centre, the latter on an experimental basis. This brings the number of Graduate and Student Sections to 19.

The Committees of the Sections have continued to work to attract members to their meetings, visits and social functions, and in some Centres there has been a considerable improvement. The Students' Lectures this year are entitled 'Man/Machine Relationships' and 'Digital Computers and How They May Help the Engineer' and are being given by W. H. Dunkley, B.SC., MEMBER, and M. V. Wilkes, M.A., PH.D., F.R.S., ASSOCIATE MEMBER, respectively.

A Conference of Honorary Secretaries of Graduate and Student Sections was held in November 1956. Suggestions made by that Conference are being considered, with other matters, by the Standing Committee on Graduate and Student Membership and Activities.

17 Oversea Activities

So far as local conditions will allow, the Oversea Branches and Committees have continued to arrange meetings, visits and social functions for local members. Several senior members whose duties took them abroad very kindly addressed meetings. This is greatly welcomed by oversea members, and senior members who are going abroad and are prepared to address members or to present an Institution paper are invited to communicate with the Secretary of The Institution.

Many oversea members have called at Headquarters during the year, nearly 200 having signed the oversea register. Letters of introduction have been provided for a large number of members travelling abroad and to other members who have taken up oversea appointments during the year. Very favourable reports have been received of the help given to these members by the Secretaries of the national engineering societies to whom the letters of introduction were addressed and with which The Institution has reciprocal arrangements.

In May 1956 Sir George Nelson, BART., then President of The Institution, visited Canada with the Secretary to attend as the official representatives of the three Home Institutions the Annual Meeting in Montreal of the E.I.C. (see also par. 46). On their way to Montreal they met officers of the American Engineering Institutions in New York.

The Joint Oversea Groups of the three Institutions in Hong Kong, Singapore and Malaya, Iraq and Persian Gulf, and West Africa have all been very active and have fulfilled a real need for meetings facilities for members of the three Institutions in the parts of the world where they have been formed. The year has seen a welcome revival in the activity of the Argentina Joint Group. As foreshadowed in last year's Annual Report, a Joint Group has been formed in Trinidad and promises to be extremely successful.

The first presentation of a Faraday Lecture oversea occurred during the year when Mr. T. B. D. Terroni's Lecture 'Courier to Carrier in Communications' was delivered some 20 times to audiences in Malaya and in Singapore. The Lecture was presented on behalf of Mr. Terroni by Mr. Dennis Smith, ASSOCIATE MEMBER. Much of the apparatus was made locally and many physical difficulties had to be overcome in presenting the Lecture. The Council take this opportunity of recording their sincere appreciation of the work of all who took part in the venture.

During the year the following Oversea Representatives have been appointed by the Council:

Brazil: Mr. E. Winstanley, B.SC.(ENG.), MEMBER (in place of Mr. C. H. de Nordwall).

Malaya and Singapore: Mr. W. Trafford, M.B.E., MEMBER (in place of Mr. J. Sharples), with Mr. P. J. Tyrrell, B.SC.(ENG.), ASSOCIATE MEMBER, as Deputy.

Pakistan: Mr. K. I. Brown, M.B.E., MEMBER (in place of Mr. R. W. Bailey).

Victoria and Tasmania: Professor H. P. Tuck, M.E., B.SC., ASSOCIATE MEMBER, as Deputy Oversea Representative for Tasmania.

Western Australia: Mr. J. B. Jukes, MEMBER (in place of Mr. F. C. Edmondson).

18 Institution Conversazione

Last year, as an experiment, the Council decided to revive the Annual Conversazione, last held in 1948, making a charge to members for tickets, and to hold it at the Royal Festival Hall. As a result some 2000 members and Institution guests with their ladies enjoyed a most successful evening on the 21st June 1956; 116 scientific and engineering exhibits were displayed. An account of the proceedings was published in the *Journal* for September 1956. It has been decided to hold a similar function at the Royal Festival Hall on the 25th June 1958.

19 Annual Dinner

A record attendance of 1495 members and guests were present at the Annual Dinner, which was held at Grosvenor House, London, on the 28th February 1957.

The Rt. Hon. Sir Oliver Franks, G.C.M.G., K.C.B., C.B.E., M.A., was the principal guest and proposed the toast of 'The Institution', to which the President replied. The toast of 'Our Guests' was proposed by Sir George Nelson, BART., Immediate Past-President, and Dr. The Rt. Hon. Charles Hill, M.P., Chancellor of the Duchy of Lancaster, replied.

20 Summer Meeting

At the invitation of the Chairman and Committee of the South Midland Centre, the Summer Meeting of The Institution was held in the area of the Centre from the 25th to 29th June 1956.

An account of the meeting, which was attended by 447 members and ladies, was published in the *Journal* for October 1956, and the warm thanks of The Institution have been

expressed to those who contributed so much to the enjoyment of all who participated.

At the invitation of the Chairman and Committee of the North-Western Centre, arrangements are being made to hold a Summer Meeting in the area of the Centre from the 1st to 5th July 1957.

21 Faraday Lecture

This year's Faraday Lecture, 'Nuclear Energy in the Service of Man', was presented by Dr. T. E. Allibone, D.SC., F.R.S., MEMBER, at public meetings held in Swansea, Bristol, Rugby, Birmingham, Leicester, Southampton, London, Belfast, Leeds, Edinburgh, Newcastle upon Tyne, Manchester and Liverpool. In Birmingham and Leicester additional lectures were given before audiences of senior schoolchildren in conjunction with the Local Education Authority. The lecture was outstandingly successful and everywhere that it was given the number of applications for tickets exceeded by far the seats available. With the co-operation of the British Broadcasting Corporation a special televised version of the lecture was broadcast by Dr. Allibone.

The Council are very grateful to Dr. Allibone, and to his Company, Associated Electrical Industries Ltd., for their support.

22 Committee on Electrical Exhibitions

The Rt. Hon. Viscount Hailsham, P.C., Q.C., Minister of Education, has accepted an invitation to open, on the afternoon of Monday, the 20th May 1957, the new Electrical Power Collection at the Science Museum. Her Majesty's Government, and the supply and manufacturing sides of the industry, have collaborated in making the new Collection possible.

23 Exhibitions of Outstanding Scientific Interest

Exhibits dealing with the following developments of scientific interest have recently been shown in the Institution building:

Prototype of Crystal-Controlled Talking Clock.
Preservation of Wood Poles.
Aircraft Aerials.

and the following are in preparation:

Irradiation of Polythene with High Energy Particles.
Microwave Valves and Valve Guides.
Linear Accelerators.

Offers of other subjects for exhibition will be most welcome, and if sent to the Secretary will be brought to the attention of the Exhibitions Committee.

24 Institution Building

The possibility of embarking upon a major scheme for a new building has been constantly under examination for a long period, but in view of the exceptionally high cost of such a project under existing economic conditions, it is now felt that it would be advisable instead to carry out a limited modification of the existing building in order to meet present demands and increased requirements in the future. The Joint Building Sub-Committee of the Finance and General Purposes Committees have been investigating this problem and as soon as a satisfactory scheme has been prepared full particulars will be given.

SECTION C Technical Investigations

25 Codes of Practice

The Council for Codes of Practice (CP/–), which was reorganized in 1954 with the support of the professional Institutions, operates within the framework of the British Standards Institution, with the status of a Divisional Council. Electrical Codes are prepared under the supervision of its Codes of Practice Committee for Electrical Engineering (ELCP/–), the secretariat for which is provided jointly by The Institution and the British Standards Institution. The Institution continues to provide the secretariat for the majority of the Electrical Code Drafting Committees. Codes dealing with radio interference abatement are referred to in par. 26.

The following Code has been issued during the year:

C.P. 1005: Use of electronic valves, Part 3: Photocells, transmitting valves and cold-cathode gas-filled valves.

Amendments have been published to the following existing Codes:

C.P. 323 (1948): Private electric generating plant.
C.P. 324.201 (1948): Installation of domestic electric space-heating equipment.
C.P. 327.101: Telephones and telegraphs—public services.

Also an amendment common to all Codes in the telecommunication series numbered C.P. 327.

Drafts of the following new Codes have been issued for comment:

Earthing.
Maintenance of electrical switchgear.
Maintenance of insulating oil for transformers and switchgear.

The drafting of the following Codes is proceeding:

C.P. 321: Electrical installations, to take the place of the existing C.P. 321: Electrical installations—general, and C.P. 321.101: Choice, installation and maintenance of electric wiring systems.
Use of electronic valves, Part IV, consisting of:
Section 9: Additional recommendations for magnetrons.
Section 10: Additional recommendations for special-quality valves.

The partial or complete revision of the following Codes is under consideration:

C.P. 321.102: Installation and maintenance of electrical machines, transformers, rectifiers, capacitors and associated equipment.
C.P. 324.102: Provision of electric lighting in schools.
C.P. 326.101: Protection of structures against lightning.
C.P. 327.102: Telephones and telegraphs—private services.
C.P. 327.201: Broadcast reception—sound and television by radio.
C.P. 327.404/402.501: Electrical fire alarms.
C.P. 1002: Abatement of radio interference from electro-medical and industrial radio-frequency equipment.
C.P. 1003: Installation and maintenance of flameproof and intrinsically-safe electrical equipment for industries other than coal mining.

C.P. 1003 is also to be extended to give guidance on alternative techniques such as the ventilation of enclosures with uncontaminated air or inert gas.

The preparation of new Codes on the following subjects has been authorized:

Climate proofing of electrical equipment.
Measurement and abatement of radio interference in aircraft.
Loading of transformers to B.S. 171.

Contact is maintained with Oversea Representatives of the Council and Secretaries of Oversea Branches and Committees, to whom new Codes and drafts are circulated.

26 Committee on Radio Interference

The need for interference abatement in the higher-frequency broadcasting and television bands (Bands II and III) is being explored by a number of the bodies represented on the Committee on Radio Interference.

The activities of a number of Sub-Committees, convened jointly by The Institution and the British Standards Institution, who are examining various technical issues—one of which deals with relations with the special international Committee on Radio Interference (C.I.S.P.R.)—have continued to receive the support of the Committee. The Committees dealing with Codes of Practice (see par. 25) maintain liaison with the Committee on matters of policy, and with Technical Committee ELE/32 of the British Standards Institution on matters of standardization.

The advice of the Committee is available to the Postmaster General on any matters within their purview which may arise.

27 Committee on Regulations for the Electrical Equipment of Aircraft

This Committee, and the Committee on Radio Equipment for Civil Aircraft, are considering proposals from the Air Registration Board for the amendment of the non-mandatory part of the British Civil Airworthiness Requirements which deals with voltage and frequency tolerances in aircraft electrical supplies.

28 Committee on Radio Equipment for Civil Aircraft

The Committee have formulated, at the request of the Air Registration Board, maximum tolerable levels of radio interference from complete electrical installations in aircraft, and have recommended that a British Standard Code of Practice be drawn up to give guidance on methods of meeting these levels.

29 Model Forms of General Conditions of Contract

New Model Forms B.1—Export Contracts, with delivery f.o.b. or c.i.f., and C—Home without Erection—for sale of Electrical and Mechanical Goods, other than Electric Cables, have been promulgated on the authority of the Council of The Institution and of the Council of The Institution of Mechanical Engineers.

Preparation of further Model Forms to complete the range for export contracts will proceed in the following order:

B.2.—Export Contracts with delivery f.o.b. or c.i.f., including Supervision of Erection.
B.1.SF.—Export Contracts with delivery f.o.b. or c.i.f. (Short Form).
B.4.—Export Contracts with delivery f.o.b. or c.i.f., including Erection on Site.

30 Wireless Telegraphy Act, 1949

At the request of the Postmaster General, the President and Council, acting under the provisions of this Act, have nominated eight new members of the Panel from which the Postmaster General appoints his Advisory Committees.

A new Advisory Committee to study interference caused by industrial, scientific and medical equipment has been set up, and for this, as in the preceding cases, The Institution jointly with the Post Office will provide the Secretariat.

31 Economic Commission for Europe: Working Party on International Forms of Contract for Heavy Engineering Equipment

Twelve sessions of the Working Party have been held in Geneva since its formation in 1951.

On the nomination of the Council and of the Council of The Institution of Mechanical Engineers, H.M. Government appointed Mr. J. F. St. G. Shaw, B.SC.(ENG.), MEMBER, to serve as one of the U.K. delegates to the Eighth and subsequent sessions of the Working Party. Mr. K. F. A. Johnston, B.A., the second nominee of the two Institutions, and Mr. H. B. Morton, continue to serve.

The above named are members of the Joint Committee with The Institution of Mechanical Engineers, and The Institution's own Committee on Model Forms of General Conditions of Contract.

32 Extra Mural Committee on the Application of Electricity to Industrial Process Heating

The Extra Mural Committee on the Application of Electricity to Industrial Process Heating, of which Sir John Hacking, PAST-PRESIDENT, is Chairman, provides a link with the International Union for the Study of Electro-Heat.

Its terms of reference are 'to discuss, co-ordinate and foster activities likely to advance the application of electricity to industrial process heating and to report from time to time to the Council of The Institution of Electrical Engineers'.

In response to an approach from the Council, the International Union agreed to accept the membership of the Committee as an affiliate rather than as a full member.

SECTION D Joint Activities with Other Bodies

33 Co-operation between Engineering Institutions

Maintaining their close collaboration, the Presidents of The Institution of Civil Engineers, The Institution of Mechanical Engineers and The Institution of Electrical Engineers have met at intervals to interchange views on matters of common interest and concern.

Joint action is being taken by the three Institutions in the rapidly growing field of automation and computation. An Exploratory Conference of interested bodies was held on the 6th March and a compact, but broadly representative Investigating Committee, appointed at that Conference, is to make recommendations for the best means of ensuring collaboration, interchange of information, and representation of the British point of view at international level.

The work of the Joint Advisory Committee on Education (JACE) is described in par. 55 and of the British Nuclear Energy Conference in par. 35.

34 Parliamentary and Scientific Committee

This Committee provides a meeting place for Members of Parliament on the one hand and representatives of pure and applied sciences on the other.

The Institution supports the Committee as an Associated Member, and Sir Harold Bishop, C.B.E., B.SC.(ENG.), PAST-PRESIDENT, continues as the Council's representative.

35 The British Nuclear Energy Conference

The Conference continues very successfully to co-ordinate the work of the adhering societies in the technology of nuclear energy.

The Conference has been extended by the adherence of The Iron and Steel Institute and of The Institute of Metals.

Sir Josiah Eccles, C.B.E., D.SC., PAST-PRESIDENT, Dr. Willis Jackson, D.SC., DR.SC.TECH., F.R.S., VICE-PRESIDENT, and the Secretary serve as The Institution's representatives on the Board of the Conference.

36 British Council

There have been frequent contacts with the Science and Engineering, and Visitors' Departments, so that persons who visit this country under the British Council's auspices, and whose interests are in electrical engineering, have the opportunity of visiting The Institution and of being invited to take part in its technical activities.

Mr. T. G. N. Haldane, M.A., PAST-PRESIDENT, has continued to serve as the Council's representative on the Science Advisory Committee, and the Secretary of The Institution on the Science and Engineering Panel.

The work of the Soviet Relations Committee of the British Council has also been supported (see par. 52).

37 British Standards Institution

Support for the work of the British Standards Institution has been maintained. Full details of the Council's representation on the Engineering Divisional Council, the various Industry Standards Committees and many Technical Committees concerned with individual British Standards were published in the *Journal* for January 1957.

For the preparation of Codes of Practice see par. 25.

For the British National Committee of the International Electrotechnical Commission, see par. 48.

38 Electrical Research Association

Support for the work of the Association has continued. Professor J. Greig, M.SC., PH.D., MEMBER, and Mr. A. W. Montgomery, O.B.E., B.SC.TECH., MEMBER, serve on its Council as the nominees of the Council of The Institution.

39 Professional Engineers' Appointments Bureau

The Council's interest in the Bureau has been maintained and their representatives continue to serve on the Board of the Bureau and on its Electrical Engineers Committee. The Bureau has been active in making nominations to supply vacancies and in other ways, and in particular its advisory services were extensively used by engineers and employers on a number of matters relating to employment.

A large number of inquiries for engineers was received from oversea, particularly from the United States of America and Canada. In consequence of the increasing number of inquiries concerning the prospects of employment in the Commonwealth, the Registrar of the Bureau was able to offer oversea employers a good selection of applicants.

40 Engineers' Guild

With the Councils of the two sister engineering Institutions, the Council has been represented at meetings of the Joint Consultative Committees of the four organizations, which has the following terms of reference:

'To consider matters of common concern to the three Institutions and to the Engineers' Guild and to report as necessary to the respective Councils.'

41 National Inspection Council for Electrical Installation Contracting

The National Inspection Council was incorporated in August 1956, The Institution's representatives on the Registration Board being Mr. S. E. Goodall, M.SC.(ENG.), VICE-PRESIDENT, with Mr. R. A. Marryat, B.SC.(ENG.), MEMBER, as alternate, and Mr. Forbes Jackson, MEMBER, with Mr. S. J. Emerson, M.ENG., MEMBER, as alternate.

On the invitation of the Council of The Institution, the N.I.C. have nominated Mr. E. J. Sutton, MEMBER, their Chief Technical Officer, to serve on the Wiring Regulations Committee.

42 British Electrical Power Convention

The Council continue to support the British Electrical Power Convention and are represented on the Council of the Convention by Mr. R. W. Mountain, B.SC.(ENG.), MEMBER, with the Secretary acting as deputy.

43 Conference of Commonwealth Engineering Institutions

For the next meeting of the Conference, which is to take place in Australia, the dates 19th March to 2nd April 1958 have been chosen.

44 EUSEC—Conference of Representatives from the Engineering Societies of Western Europe and the United States of America

At the invitation of the American member societies, the next meeting of the Conference will be held at the end of April 1958 in New York.

The Secretaries of the three Home Engineering Institutions recently met the Secretaries of other EUSEC societies in Brussels for a preliminary discussion of the Agenda of the 1958 Conference.

45 Society of Chemical Industry

On the occasion of the 75th Anniversary of the foundation of the Society of Chemical Industry a congratulatory letter was sent to the Society in the name of the President and Council.

46 Engineering Institute of Canada

The seventieth Annual General Meeting of The Engineering Institute of Canada, held from the 19th May to 1st June 1956, was attended by Sir George Nelson, BART., then President, and the Secretary of The Institution.

During the course of their visit the President addressed a meeting arranged by the Joint EIC/IEE Committee in Toronto, and the Secretary addressed meetings of the E.I.C., to which members of The Institution living in the vicinity were invited, in Winnipeg and Regina.

Other senior members, including Mr. T. E. Goldup, C.B.E., VICE-PRESIDENT, have visited Canada and whenever their duties have allowed, have addressed meetings of members.

47 Nikola Tesla Centenary Celebrations

Sir Arthur Fleming, C.B.E., D.ENG., LL.D., HONORARY MEMBER and PAST-PRESIDENT, represented the Council at the Celebrations in Belgrade during July 1956 of the Centenary of the birth of Nikola Tesla.

The Memorial Lecture organized by The Institution in 1943, on the occasion of Tesla's death, was recalled by the organizers of the Celebrations and was reflected in the cordial reception given to Sir Arthur, who delivered a commemorative address on Tesla's work to the assembled delegates.

48 International Electrotechnical Commission

The Institution's support of the work of the International Electrotechnical Commission has continued.

49 Commission Mixte Internationale

Mr. P. J. Ryle, B.SC.(ENG.), MEMBER, acts as the Council's representative on the Commission Mixte Internationale, which is concerned with studies for limiting the interaction of power and telecommunication systems.

50 World Power Conference

Mr. J. R. Beard, C.B.E., M.SC., PAST-PRESIDENT, serves as the Council's representative on the British National Committee of the Conference.

51 International Commission on Illumination (C.I.E.)

Through their adherence to the National Illumination Committee of Great Britain, the Council's support of the C.I.E. has continued. Mr. G. T. Winch, MEMBER, has been appointed to one of The Institution's three seats on the Committee of Administration of the C.I.E.

52 Soviet Relations Committee of the British Council

The team from the three Institutions to which reference is made in the Introduction to the Report included Mr. H. E. Dance, M.ENG., M.I.MECH.E., A.M.I.C.E., MEMBER, Dr. H. L. Haslegrave, WH.SC., M.A., PH.D., M.SC.(ENG.), M.I.MECH.E., MEMBER, Mr. G. S. C. Lucas, O.B.E., VICE-PRESIDENT, and the Secretary, among its members. The report of the team was presented at a joint meeting of the three Institutions held at The Institution of Civil Engineers on the 25th February 1957.

A team of Russian engineers and educationists paid a corresponding visit to this country at the end of October and the beginning of November 1956.

In September 1956 a team sponsored by The Institution of Civil Engineers, of which Sir John Hacking was the leader, visited the Soviet Union to study hydro-electric engineering developments. The report of this team will be presented at a meeting to be held at The Institution of Civil Engineers on the 20th May 1957.

SECTION E Education

53 Education and Training

One of the most important subjects considered by the Education and Training Committee was the Government's Report on Scientific and Engineering Manpower in Great Britain, which discussed the demand and supply of scientists and technologists over short and long term periods. The Institution has continued to implement its policy of stimulating recruitment to the electrical engineering profession, and attention is now being focused on the recruitment of girls as well as boys to fill the future needs of the profession.

The film *The Inquiring Mind* made during the previous year, has been well received in this country and in the Commonwealth. It has been shown in a large number of public and grammar schools and has recently been introduced with considerable success to audiences of schoolgirls. The Institution has also taken part in a number of Careers Exhibitions throughout the country. Discussions are now taking place on the employment of women in the field of electrical engineering.

Consultation with the Ministry of Labour and National Service has continued and the Ministry has modified the deferment arrangements for graduates so that candidates with degrees in mathematics and science may now qualify for deferment in order to complete a two-year graduate apprenticeship in electrical engineering, provided that within that period they pass the appropriate parts of The Institution Examination. The Ministry have also issued regulations for the deferment of technicians (see par. 67).

The Joint Committee on Management Training, consisting of members of The British Institute of Management and The Institution, have produced an Interim Report and specimen syllabus for a course in management studies which would extend over two years and would include three short periods of full-time study at a university or college. Its aim would be to equip professional engineers for administrative work at the higher management levels. The British Institute of Management is also holding a Summer School in Production Management in 1957, the planning of which has been undertaken by a Committee on which the Council are represented.

Discussions are taking place on the need for conversion and other preparatory courses prior to entry to full-time courses of higher education leading to a degree or diploma; in the Committee's view the need for such courses is connected with the acute shortage of science teachers in schools.

The provision of equipment for colleges in Colonial territories is in the hands of the Advisory Committee on Colonial Colleges of Arts, Science and Technology, but the Council consider it equally important that steps should be taken to assist the colleges in obtaining an adequately qualified staff, and discussions are taking place in an endeavour to discover how best this can be achieved.

The Institution has become a supporting member of the British Association for Commercial and Industrial Education, which includes amongst its membership such institutions as the universities, Regional Advisory Councils, and the Department of Scientific and Industrial Research.

54 Technological Education

The Council have observed with pleasure the development during the year of the work of the National Council for Technological Awards under the Chairmanship of Lord Hives and they have welcomed the decision to distinguish the title of the engineering award from that in other technologies. The National Council published in May 1956 a memorandum on the recognition of courses in Technical Colleges for the purpose of the award of the Diploma in Technology. The Council have also noted with great satisfaction the progress made by the Ministry of Education in dealing with the classification of technical colleges. The policy now followed

accords closely with that long advocated by the Council and their support for these measures has been given wholeheartedly.

55 Joint Advisory Committee on Education

Mr. S. E. Goodall, M.SC.(ENG.), VICE-PRESIDENT, has been elected Chairman of the Joint Advisory Committee on Education (JACE) for the year 1957.

During the past year, JACE has been responsible for the collation of the material in answer to the two questionaries circulated from the United Kingdom for the Third Conference on Engineering Education of the Engineering Societies of Western Europe and the United States of America (EUSEC), to be held in Paris in September 1957 (see par. 70).

JACE has also continued to be concerned with technological education generally, and has been advised of the policy and activities of the National Council for Technological Awards through those members of the Committee who also represent the Engineering Institutions on the Board of Studies in Engineering of that Council.

Discussions have been taking place on the suitability of the Common Preliminary Examination as evidence of the ability of candidates to embark on a course of professional education. The Council are not prepared to participate in this scheme after 1960.

56 Careers Exhibitions

The Council have continued to give their support to careers exhibitions and The Institution's display was made available to Rotary Clubs at Caterham and Bognor Regis for their exhibitions, and to the Brockenhurst County High School during their Careers Week when the stand was manned by members of the Southern Centre of The Institution. Exhibition material has also been made available to the organizers of a number of other careers meetings, including those at Bathgate, Dalkeith, Galashiels, Leek and Larne.

In April 1957 The Institution provided a stand in a section of the Electrical Engineers' Exhibition at Earls Court devoted to education and training in the electrical engineering industry.

57 Examinations

The Examinations Committee have continued their reassessment of the qualifications and courses by which candidates can be exempted from the Institution Examination under the standards laid down in the 1953 Examination Regulations.

A revised Schedule of Accepted Educational Qualifications has been produced and was published by the Council in September 1956 indicating the position at that date. As new and modified courses are approved for exemption purposes each month, corrigenda or revised schedules will be issued at intervals until stability has been reached.

There has been a marked increase in the number of industry-based sandwich diploma courses which have been introduced, mainly in Colleges of Advanced Technology and Regional Colleges, and in the number of courses in preparation for Part III of the Institution Examination, which have been mainly organized on a part-time basis.

The Committee have considered the standing of the Dip.Tech.(Eng.) award of the National Council for Technological Awards and have decided to assess this qualification for the purpose of exemption from the Institution Examination, in the same way as an engineering degree.

A new edition of Laboratory Courses in Preparation for the Institution Examination has been prepared and was published by the authority of the Council in September 1956.

58 Theses

During the 1956–57 session five candidates submitted theses, three of which were accepted. Corresponding figures for the 1955–56 session were four theses submitted, all of which were accepted.

59 Institution Examination

During 1956 the Standing Committee for the Engineering Institutions' Part I Examination was expanded by one member and now comprises representatives of:

The Institution of Civil Engineers.
The Institution of Mechanical Engineers.
The Institution of Electrical Engineers.
The Institution of Municipal Engineers.
The Institute of Marine Engineers.
The Institution of Gas Engineers.

The last Annual Report foreshadowed that the Engineering Institutions were not entirely satisfied with the effectiveness of the English Examination as a test of a candidate's knowledge of this subject. A Panel have considered the question and the Standing Committee have accepted their recommendation that the Engineering Institutions should not conduct an examination in English after 1960. They are agreed, however, that an adequate qualification in English Language is essential, but that this should be demonstrated by candidates passing examinations which have been designed to test general education and that these examinations should be taken while at school or as soon as possible thereafter.

The respective Councils have endorsed this decision and after 1960 English will not appear in the Part I Examination, but all candidates wishing to qualify as members of the Institution will be required to offer an approved qualification such as a pass in English Language in the General Certificate of Education at 'O' level or a pass in the subject of English in the Scottish Leaving Certificate at the Higher Grade.

The remainder of the Institution Examination, comprising Parts II and III, was held in April and October 1956 for candidates in the British Isles; in April 1956 for oversea candidates in the Northern Hemisphere; and in October 1956 for oversea candidates in the Southern Hemisphere. The Section B Examination was held for the last time in April 1956. This was the final opportunity for candidates to qualify under the old Regulations and this is reflected in the large

	April 1956		*October 1956*	
	Number of centres	Number of candidates	Number of centres	Number of candidates
Home Centres (including the Republic of Ireland)				
Part I	12	128	8	113
Part II	5	14	8	26
Part III	3	11	3	10
Section B	11	167		
English (at Technical Colleges)	160	5165	54	581
Oversea Centres				
Part I	31	207	7	23
Part II	6	54	7	29
Part III	4	15	3	4
Section B	51	301		

number of candidates presenting themselves for examination compared with previous years.

The table at the foot of the previous page shows the number of candidates for the various Parts of the Examination.

The figures for the Part I Examination include only those candidates seeking membership of The Institution.

60 Common Preliminary Examination

The original purpose of the Common Preliminary Examination was to set a minimum standard of general education to be reached by all candidates for Student membership, but the majority of entrants now possess suitable exempting qualifications. This tendency has become more noticeable since the advent of the General Certificate of Education which may be taken after a student leaves school, and the number of candidates now taking the Common Preliminary Examination shows a decline from year to year.

The Examination is administered by the Engineering Joint Examination Board, on which the principal Engineering Institutions are represented. It is held twice yearly in April and October, both at home and abroad. In 1956, 24 candidates for membership of The Institution were examined at home and 94 abroad, compared with 36 and 116 respectively in 1955.

61 National Certificates and Diplomas in Electrical Engineering

In association with the Ministry of Education for England and Wales, the Scottish Education Department, and the Ministry of Education for Northern Ireland, The Institution has been responsible for the award of National Certificates and Diplomas in Electrical Engineering to students successfully completing approved courses at 217 technical colleges in the United Kingdom.

When the first National Certificate examinations were held in 1924, 282 students qualified for an Ordinary National Certificate and 43 students qualified for a Higher National Certificate. Growth since that date is illustrated by Tables A, B and C.

During the year there has been an increase in the number of industry-based sandwich courses which have been approved for the award of a Higher National Diploma. It is to be expected that an increasing number of student apprentices

Table A

	Number of courses	
	1955	1956
England and Wales	721	707
Scotland	51	58
Northern Ireland	14	15
Total	786	780

Table B **National Certificates Awarded**

	O.N.C.		H.N.C.	
	1955	1956	1955	1956
England and Wales ..	3226	3512	2036	2153
Scotland..	166	167	104	96
Northern Ireland ..	22	43	24	19
Total	3414	3722	2164	2268

Table C **National Diplomas Awarded**

	O.N.D.		H.N.D.	
	1955	1956	1955	1956
England and Wales ..	42	21	75	87
Scotland..	—	—	13	18
Total	42	21	88	105

will obtain their professional educational qualification by this route or by other industry-based courses and that eventually the Higher National Certificate will meet mainly the needs of senior technicians wishing to equip themselves for positions of responsibility. The above tables indicate, however, that there has been no significant change in the number of students taking National Certificate courses compared with previous years and that it may be some time before the new trend is reflected in the National Certificate statistics.

62 Page Prize

The Page Prize, which takes the form of textbooks or instruments to the value of five guineas, is awarded each year to the candidate who is adjudged as having the best performance in the final examinations of the Higher National Certificate in Electrical Engineering.

In 1956 the quality of the eligible students made the task of final selection difficult, and the Council decided to make two awards. The successful candidates were Mr. K. G. Burling of the Reading Technical College and Mr. P. Jarvis of the Nuneaton Technical College and School of Art.

63 Henry Nimmo Prize

To commemorate the memory of the late Mr. Henry Nimmo, formerly Honorary Treasurer of The Institution and a member of Council, a fund provided by Mrs. Nimmo is being used to institute a prize which will be awarded to students of outstanding merit who have obtained the Electrical Technicians' Certificate of the City and Guilds of London Institute.

A preliminary selection will be made of a small group of students who obtain the highest marks in the intermediate examination. The Prize will be awarded to the student who obtains the highest mark at this stage and who shows an outstanding performance in the subsequent years of the course on which he is awarded the Electrical Technicians' Certificate. A further condition of the award is that the student must be following a satisfactory scheme of technician training in industry.

64 Scholarships

In 1956 the number of candidates applying for Research and Student Scholarships was substantially the same as in 1955, although there was a marked increase in the number of those applying for Graduate awards.

Among the most interesting subjects of research carried out by the successful applicants for Research Scholarships were investigations into the ultra-sonic properties of solid materials, an investigation into binaural hearing with particular reference to sound ranging and stereophony, and research into bandwidth compression by the application of communication theory.

The general standard of the candidates applying for Student Scholarships was on the whole higher than in the previous year. The Arthur Fleming Scholarship and the Geipel Scholarship were both awarded for the first time in 1956. In both cases the candidates are pursuing industry-based sandwich diploma courses in electrical engineering.

65 Education Discussion Circle

There have been eight Meetings of the Education Discussion Circle, with an average attendance of 51. The presentation of electrical engineering subjects to students usually predominates among the subjects for discussion, but the meetings are not restricted to those engaged in teaching and all members of The Institution who are interested in exchanging views on education and training in the electrical engineering industry are welcome.

In June a programme of visits was arranged under the general theme of 'materials' and a number of establishments in the London area were visited.

66 Joint Committee on Practical Training

The Joint Committee on Practical Training in the Electrical Engineering Industry is composed of members appointed by the Council of The Institution in consultation with the Council of the British Electrical and Allied Manufacturers' Association, The Radio Industry Council and other interested bodies. The Joint Committee met three times during 1956 and completed their Report on the Training of Graduates which was published by the Council in January 1957.

At a Press Conference announcing the publication of the Report attention was directed to the contribution which must be made by smaller firms. In implementing training programmes the smaller firms have often been handicapped by the limited scope of their training facilities and the Joint Committee hope that the development of co-operative and group training schemes will help to solve this problem.

The Joint Committee are now preparing a complementary Report on the Training of Professional Electrical Engineers through Student Apprenticeship, in which they will give particular attention to industry-based Sandwich Schemes. A Panel set up to consider this matter in detail have met six times, and it is expected that their Report will be completed in 1957.

67 Courses for Electrical Technicians

In the summer of 1956 the City and Guilds of London Institute published final details of the schemes of Courses and Examinations for Electrical Technicians which had been developed from proposals published in 1954 by the Council in an Interim Report on Courses for Electrical Technicians. Provision has so far been made for the award of Technicians' Certificates for those concerned with plant and machinery, power generation and supply, and industrial electronics. Courses for the new examinations have been offered at 40 technical colleges during the academic session 1956–57.

Following representations by the Council to the Ministry of Labour and National Service in November 1955 the Minister decided in June 1956 that bona fide technician trainees would be eligible for deferment of call-up until the age of 21 provided they were following a planned syllabus of training, and were undertaking suitable part-time study (where this is available) to qualify for a City and Guilds Certificate, National Certificate or other appropriate award.

68 Advisory Service on Education and Training

Each year the Advisory Service receives numerous inquiries from boys seeking information about the education and training necessary for the Chartered Electrical Engineer. These inquiries showed an increase in 1956 and it was encouraging that a small number of requests for information came from girls.

The facilities of the Advisory Service continued to be used by Student and Graduate members, usually for advice about industrial training programmes. The Service is also available to Government Departments and is used principally by the Ministry of Labour and National Service from whom numerous inquiries are received affecting the deferment of call-up of electrical engineering students.

69 Technical Publications Panel

The work of this Panel is concerned with encouraging experienced engineers to write textbooks on subjects which have not been given adequate treatment by British authors and to enlist the interest of publishers. In order to remove possible misunderstanding about their activities, the Panel prepared a short article on their purpose and work which was published in the *Journal* for December 1956. Suggestions from members about subjects for new books are welcomed and if the Panel are convinced that a new book is required, expert advice can be arranged for an interested author or publisher about the most useful scope for the work.

70 Third EUSEC Conference on Engineering Education

The third EUSEC Conference on the Education and Training of Professional Engineers has again been deferred until the 16th to 20th September 1957, owing to the fact that several participating countries have been unable to return their questionaries by the agreed date.

71 Reception for Oversea Graduates

One of the last functions at which Sir George Nelson, BART., officiated before retiring as President was a Reception for Oversea Graduates. The visitors included a number of Athlone Fellows who had just arrived from Canada and also F.B.I. Scholars from various Commonwealth countries. Altogether 27 different countries were represented.

An address was given by the President and the film *Calder Hall* was shown. A small exhibition was arranged of items chosen to illustrate British contributions to electrical engineering, including a model of a nuclear power station, electron irradiation of materials and a demonstration of industrial television.

72 Lectures for Young People

The subject of this year's Christmas Lecture for Older Schoolchildren was 'The Evolution of Automation' and was delivered on the afternoons of the 1st and 2nd January 1957 by Mr. J. F. Coales, O.B.E., M.A., MEMBER. A total of over 600 schoolchildren, including a large proportion of girls, attended the Lecture.

SECTION F

Institution Library and Publications

73 Library

The main collection contains nearly 10 000 books, over 11 000 volumes of periodicals, reports, etc., and several thousand pamphlets. Over 580 current periodicals are being received.

The following statistics indicate the additions to the Library during the year, the use made of the Reference Library by members and non-members, and the extent of borrowing from the Lending Library. Figures for 1955 are shown for comparison.

Reference Library

Year	Additions to the Library				Readers	
	Books		Pamphlets			
	Presented	Bought	Presented	Bought	Members	Non-members
1955	149	172	1 094	104	7 760	629
1956	156	161	1 024	108	8 533	782

Lending Library

Year	Books added to the Lending Library	Books issued	Borrowers
1955	154	5 172	1 904
1956	132	5 338	1 860

In addition, full use has been made of the facilities of the Science Library and Lewis's Library; the Science Library Photocopy Service has been used on 572 occasions. Particulars of the latter service have been published in the *Journal* (January 1956).

74 The *Journal* and *Proceedings* of The Institution

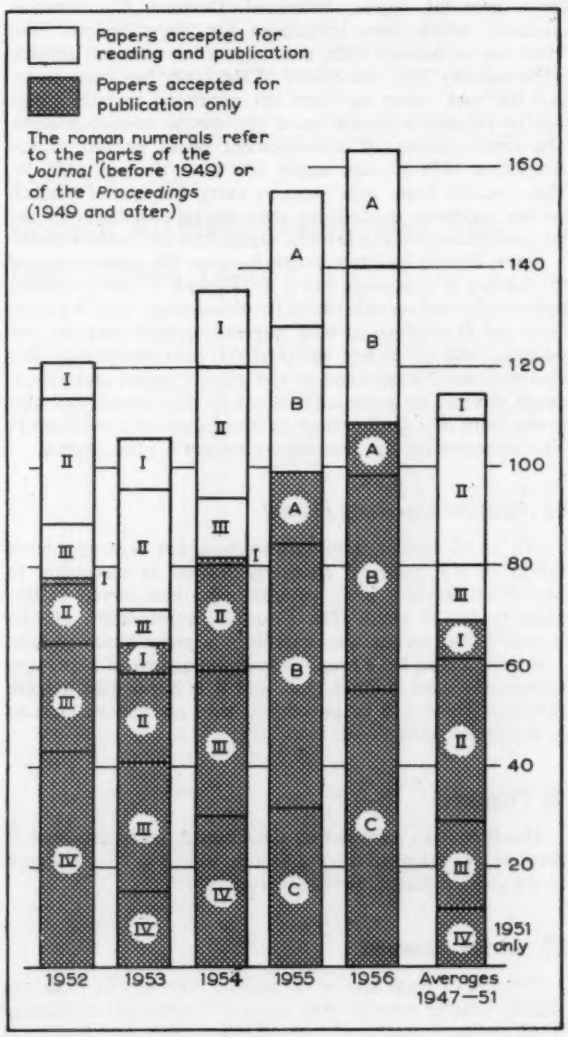
The *Journal* is supplied to all members, free of charge. The numbers of non-members who subscribed for the *Journal*, and of members and non-members who subscribed for the *Proceedings*, in 1956 are given below, together with the numbers of pages in the *Journal* and the three Parts of the *Proceedings*. Corresponding figures for 1955 are included for comparison.

	No. of pages		No. of members receiving copies		No. of non-member subscribers	
	1955	1956	1955	1956	1955	1956
Journal ..	786	790	All members		1 666	1 894
Proceedings:						
Part A ..	876	644	15 831	16 369	1 940	2 106
Part B ..	872	798	11 309	11 726	2 494	2 493
Part C ..	296	460	6 730	6 816	1 568	1 741
	2044	1902				

The numbers of papers published in the *Proceedings* during the five years 1952–56, and the average numbers for 1947–51, are shown graphically in Fig. 4. Addresses, lectures and progress reviews are not included, nor are the papers presented in connection with the following Conventions, which, together with the discussions, were published in special issues of the *Proceedings*, as indicated:

Television Convention, 1952, **99**, Part IIIA, Nos. 17–20.
Symposium on Insulating Materials, 1953, **100**, Part IIA, No. 3.
Convention on Electrical Equipment of Aircraft, 1956, **103** A, Supplement No. 1.
Convention on Digital-Computer Techniques, 1956, **103** B, Supplements Nos. 1–3.

The monthly publication of the *Journal* has continued along the new lines established in January 1955. The only notable



4 *Numbers of papers published*

change in its content in the year under review has been the start of regular publication of interpretations of The Institution's Wiring Regulations; these will appear at approximately quarterly intervals. 'Home Events' has been split into 'London Report' and 'News from the Centres', corresponding to the old 'London Activities' and 'Local Centre Activities'. On a suggestion from an oversea member, a new contents page is being used. This includes detailed indexes of Institution papers mentioned in the *Journal* under 'A Review of the *Proceedings*, Parts A and B' and 'Monographs and Papers published individually this month'. Minor alterations in typography have been made, to improve appearance and to make some economies against the still rising costs of production. In particular more economical layouts have been adopted for 'Forthcoming Events at Savoy Place' and 'Monographs and Papers published individually this month', and the size of type used for the obituary notices has been further reduced, since nearly twice as many obituaries of Members and Companions were published in 1956–57 as in each of the three previous years. Universal Decimal Classification numbers, which were introduced for 'short reviews' and 'synopses' in January 1956, now appear for technical articles. Since January 1957 the colour of the cover has been green, and the back cover has been left unprinted to reduce cost and to provide a useful space for special announcements. The total number of advertisement pages printed in the *Journal* in 1956–57 was nearly 100 more than in 1955–56. The Council hope next year to carry out some research among members to find out the relative popularity of the items in the *Journal* and to invite suggestions for improvements.

Paper, Reprint and Monograph Services.—A paper accepted for reading at a meeting, like a monograph, is first published individually and republished in the *Proceedings* later. Reprints from the *Proceedings* of such papers, together with the discussions, and of papers accepted for publication only, are also published. Particulars of the paper, reprint and monograph services are given each month in the *Journal*, and also in the form of a leaflet which is distributed to non-members who subscribe for the *Proceedings* but not for the *Journal*.

75 *Students' Quarterly Journal*

Mr. E. M. Hickin, ASSOCIATE MEMBER, has been appointed Editor of the *Students' Quarterly Journal* in succession to Mr. J. H. Reyner, B.SC., MEMBER, who had served in this capacity for 26 years. The Council's appreciation of Mr. Reyner's long service was marked by a presentation to him.

Improvements have been made in the quality of paper and typography used in the *S.Q.J.*, and it is hoped that a more attractive cover will be introduced with the volume starting in September 1957.

76 Premiums

The Premiums awarded by the Council for papers read at meetings, or accepted for publication only will be announced in the *Journal* during the Summer of 1957.

77 *Science Abstracts*

The size of each Section of *Science Abstracts* in 1956 was slightly smaller than in 1955, Section A (Physics) containing 9165 abstracts compared with 10160 in 1955, and Section B (Electrical Engineering) containing 4661 abstracts compared with 5403. This deficiency is not a true reflection of the number of articles published in the world's literature which, on the contrary, continues to increase from year to year, but is due rather to temporary difficulties, including those consequent upon the adoption of typewriter composition ('pro-printing'). It is hoped that the ground lost will be more than recovered in the coming year.

A whole year's publication in the new form has now been completed, including the Annual Index. This has aroused much interest, and though some expected and some unexpected difficulties have been encountered, it may be said that the year's experience has been very encouraging. Savings in cost appear at present to be disappointing but savings in time, compared to the letterpress printing of previous years, are substantial.

The first half of the cumulative 5-year index to *Science Abstracts* was published during 1956.

78 Regulations for the Electrical Equipment of Buildings

Over 63000 copies of the 13th Edition of the Regulations, which was promulgated on 1st September 1955, have been sold.

A Second Edition of the Recommended Practice for Electrical Installations in Caravans, based on the Regulations and first issued in 1954, has been issued and has received wide support, nearly 2000 copies having been sold.

During the year the practice of publishing abstracts of those interpretations of the Regulations which raise clear-cut issues and are of general interest has been placed on a regular footing, and three sets have been issued and published in the *Journal*, reprints being available from the Secretary.

Liaison is maintained with the British Standards Institution regarding British Standards cited in the Regulations, and a number of important draft Standards have been scrutinized from the aspects of safety from fire and shock. The technique of double insulation is receiving close attention.

79 Regulations for the Electrical Equipment of Ships

On behalf of the United Kingdom National Committee of the I.E.C., the Committee acts as United Kingdom Committee for liaison with I.E.C. Technical Committee No. 18. The First Edition of an I.E.C. Code of Recommended Practice for Electrical Installations in Ships has been approved for publication and outstanding matters are to be considered at a meeting to be held in Italy in May 1957 for treatment in a proposed Second Edition of the Recommendations.

The Council last year authorized the preparation of a 4th Edition of the Regulations for the Electrical Equipment of Ships, to take the place of the 3rd Edition (1939) with 1947 Supplement. Sub-Committees have made good progress with the necessary technical investigations and drafting work and their recommendations will go before the parent Committee in due course.

SECTION G Benevolent Activities

80 Incorporated Benevolent Fund

The Report of the Court of Governors for the period 1st July 1955 to 30th June 1956, together with the Accounts, was circulated with the *Journal* for September 1956; a summary

of the report was subsequently published in the *Journal* (December 1956, p. 726). For the first time subscriptions and donations showed a small decrease from £12 854 to £12 629 despite the increase in membership of The Institution. This amount is insufficient to cover normal expenditure and the Court earnestly appeal to non-subscribing members to support the Benevolent Fund of their own profession. Six legacies were received, amounting to £465.

Grants were made to 125 beneficiaries, and in assisting them the Fund also gave support to 106 dependants. The amount of these grants was £8 820 and the average amount distributed per beneficiary during the year was approximately £70.

The Fund now has six beneficiaries resident in the Crossways Trust homes at West Worthing, Brighton, and the home for the infirm at Englefield Green, and this type of accommodation has proved the most suitable for elderly people who are no longer able to look after themselves alone.

Since last year two new tenants have been accommodated on 'The Chesters' Estate, as homes have become vacant, and they have settled happily into this little community. Tenants never fail to express delight at the comfort of the houses and the lovely surroundings.

The total amount received in subscriptions and donations since the inception of the Homes Fund to the 30th June 1956 was £37 043, and in addition 228 members have signed Deeds of Covenant for the payment of subscriptions for a period of seven years.

The Accounts of the Wilde Fund were published in the *Journal* (July 1956, p. 406).

Lord Hirst Fund.—This Fund exists to assist financially persons who apply for help and are recommended to the Trustees by the Court of Governors of the Benevolent Fund as deserving, and as having rendered important services to electrical science, the electrical industry or electrical engineering. Assistance can also be given to the dependants of such persons.

On the 30th June 1956 the Fund comprised:

Capital Account investments	£11 543 3s. 10d.
Income Account investments	£3 496 19s. 2d.

which produce an annual income of about £457. The uninvested balance of the Income Account was £18 10s. 8d. Grants totalling £305 were made from the Fund during the year.

SECTION H

Institution Staff

81 The Staff

The Council express their warm thanks to the Secretary and his staff for maintaining throughout another session the high standard of service which is now traditional. The demands of a continually growing organization and the successful completion of the wide programme of activities of The Institution impose a considerable load which is cheerfully and efficiently carried.

APPENDIX A

Membership of The Institution

The changes in membership, since 1st April 1956 are shown in the following table:

	Hon. Mem.	Assoc. Mem.	Mem.	Com.	Assoc.	Grad.	Stud.	Totals
Totals at 1st April 1956 ..	15	3 842	17 232	77	2 688	11 797	4 387	40 038
Additions during the year:								
Elected	2	4	319	3	120	1 146	1 087	2 681
Reinstated ..	—	1	14	—	2	11	13	41
Transferred to ..	—	225	980	—	3	833	—	2 041
Totals ..	2	230	1 313	3	125	1 990	1 100	4 763
Deductions during the year:								
Deceased ..	1	88	130	2	30	8	3	262
Resigned ..	—	5	48	—	34	55	78	220
Lapsed	—	—	41	—	24	142	549	756
Transferred from	—	—	224	—	25	930	862	2 041
Totals ..	1	93	443	2	113	1 135	1 492	3 279
Net change ..	+1	+137	+870	+1	+12	+855	−392	+1 484
Totals at 1st April 1957 ..	16	3 979	18 102	78	2 700	12 652	3 995	41 522

APPENDIX B

Growth of Membership over the last fifteen years

Year (31st March)	Corporate Members	Non-Corporate Members	Total Membership	Annual Increase
1943 ..	11 097	11 218	22 315	1 265
1944 ..	11 924	12 634	24 558	2 243
1945 ..	12 573	14 091	25 665	2 107
1946 ..	13 447	15 711	29 158	2 493
1947 ..	14 501	16 759	31 260	2 102
1948 ..	15 206	17 701	32 907	1 647
1949 ..	16 027	18 344	34 371	1 464
1950 ..	16 648	18 900	35 548	1 177
1951 ..	17 146	19 412	36 558	1 010
1952 ..	17 757	19 496	37 253	695
1953 ..	18 510	19 272	37 782	529
1954 ..	19 552	18 944	38 496	714
1955 ..	20 355	18 943	39 298	802
1956 ..	21 089	18 949	40 038	740
1957 ..	22 097	19 425	41 522	1 484

APPENDIX C

Meetings

The following is a list of the meetings held during the 12 months ending 31st March 1957:

General Meetings		*Council and Committee Meetings*	
Ordinary Meetings ..	12	Council Meetings	11
Joint Meetings	2	London Committees	
Annual General Meeting	1	Education and Training (and Panels)	16
Annual General Meeting (Incorporated Benevolent Fund)	1	Electrical Exhibitions ..	1
Measurement and Control Section	32	Examinations (and Sub-Committees)	22
		Finance	9
c.f.	48	*c.f.*	59

General Meetings	*b.f.*	48	
Radio and Telecommunication Section		30	
Supply Section		9	
Utilization Section		14	
Informal Meetings		7	
Education Discussion Circle		8	
Special Lecture		1	
District Meetings		20	
*Local Centres			
East Midland		17	(5)
Cambridge Radio and Telecommunication Group		6	(4)
Mersey and North Wales		22	(8)
North-Eastern		20	(7)
Radio and Measurement Group		9	(4)
North Midland		17	(8)
Utilization Group		6	(7)
North-Western		8	(9)
Measurement and Control Group		5	(5)
Radio and Telecommunication Group		5	(6)
Supply Group		4	(5)
Utilization Group		5	(6)
Northern Ireland		9	(6)
Scottish		8	(6)
South Midland		18	(6)
Radio and Telecommunication Group		6	(7)
Supply and Utilization Group		6	(6)
Southern		27	(7)
Western		13	(8)
Supply Group		5	(4)
Utilization Group		5	(2)
Local Sub-Centres			
East Anglian		18	(5)
North Lancashire		12	(8)
North Scotland		16	(7)
North Staffordshire		10	(7)
Rugby		12	(6)
Sheffield		8	(5)
South-East Scotland		13	(7)
South-West Scotland		17	(6)
South-Western		8	(6)
Tees-Side		7	(7)
West Wales (Swansea)		8	(11)
*Graduate and Student Sections			
Bristol		10	(5)
Cardiff		7	(7)
East Midland		10	(9)
London		23	(11)
Mersey and North Wales		11	(8)
North-Eastern		14	(9)
North Midland		9	(9)
North Scotland		7	(3)
North Staffordshire		7	(6)
North-Western		12	(10)
Northern Ireland		7	(5)
Rugby		10	(6)
Sheffield		11	(7)
Southern		8	(5)
South-East Scotland		9	(6)
South Midland		13	(8)
South-West Scotland		5	(7)
Tees-Side		6	(7)
		666	(329)

Council and Committee Meetings	*b.f.*	59
London Committees—*contd.*		
General Purposes (and Sub-Committees)		14
Hon. Secretaries' Conference:		
Local Centres and Sub-Centres		1
Graduate and Student Sections		1
Incorporated Benevolent Fund (and Sub-Committees)		14
Informal Meetings		3
Joint Advisory Committee on Education		2
Joint Committee on Model Forms of General Conditions of Contract (and Panels)		5
Joint Committee on Practical Training in the Electrical Engineering Industry (and Panels)		17
Joint Oversea Activities		1
Joint Part I Examination (and Panels)		7
Library and Museum		1
Local Centres		2
Measurement and Control Section (and Sub-Committees and Panels)		31
Membership (and Panels)		13
Model Forms of General Conditions of Contract (Electrical) (and Panels)		2
National Certificates		
England and Wales		2
Northern Ireland		1
Scotland		1
Oversea Activities		2
Papers (and Sub-Committees and Panels)		18
Radio Equipment for Civil Aircraft (and Sub-Committees)		4
Radio Interference (and Panels)		1
Radio and Telecommunication Section (and Sub-Committees and Panels)		69
Regulations for the Electrical Equipment of Aircraft (and Sub-Committees)		1
Regulations for the Electrical Equipment of Ships (and Sub-Committees)		25
Scholarships (and Panels)		3
Science Abstracts		3
Supply Section (and Sub-Committees)		15
Utilization Section (and Sub-Committees and Panels)		19
Wiring Regulations (and Sub-Committees and Panels)		2
Other London Committees		17
Centres, Sub-Centres and Graduate and Student Section Committees (see details in parentheses in left-hand column)		329
		685

Also Code Drafting Committees convened for the Council for Codes of Practice	14
General Meetings	666
Council and Committees	685
Codes of Practice	14
Grand Total	1365

* The number of Committee meetings held are shown in each case in parentheses, and the total number of these Committee meetings is entered at the foot of the right-hand column.

APPENDIX D

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Annual General Meeting of The Institution, 1957

THE PRESIDENT, Sir Gordon Radley, took the chair at the 85th Annual General Meeting of The Institution at 5.30 p.m. on the 23rd May 1957. He submitted to members the name of Mr. M. H. Beattie as a scrutineer for the ballot for the election of new members of Council in place of Mr. G. R. Peterson, and this was agreed. The following list of authors who have presented books to the Library was taken as read:

A. Abramson
G. C. Allingham
D. A. Bell
T. H. Carr
F. T. Chapman
W. T. Cocking
H. Cotton
Sir Thomas Eades
A. A. de C. Fernandes
R. H. Garner
Professor dr ir H. C. J. H. Gelissen
J. Temple Hazell
H. W. Heckstall-Smith
C. S. Henson
A. W. Hirst
P. V. Hunter
The Right Hon. Lord Hurcomb
A. Lovichi
J. R. Mortlock
W. T. Pratt
W. E. Swale
C. E. Tibbs
G. A. Wedge
R. Willheim

The President then went on to deal with the Annual Report (p. 381), and in the course of his remarks he said:

'There is again an increase in the number of members to be recorded, the total now being 41 522, of whom over 22 000 are Corporate Members and over 12 500 are Graduates. The continuing drop in the number of Students has not escaped the notice of the Council, who have the position under constant review. It is hoped that there will be an improvement in the current year. The Bye-law revisions which were approved at the Special General Meeting held in March, last year, were allowed by the Privy Council in August, and the new subscription rates came into force on the 1st January 1957.

'Section B deals with Institution activities, which, as you will see, have been very numerous and have included three most successful conventions and the important joint meeting by transatlantic telephone cable held with our sister Institutions in Canada and the United States. Unfortunately, I have no time to review in detail all the activities of the Local Centres, Oversea Branches and Committees, but outstanding events abroad were the official visit of Sir George Nelson, then President of The Institution, and our Secretary, as the representatives of the three home Institutions, to the seventieth Annual General Meeting of the Engineering Institute of Canada, and the first presentation oversea of the Faraday Lecture, by Mr. Dennis Smith, in Malaya and Singapore. There is an interesting account of that in the last issue of the *Journal*.*

'There was a record attendance of nearly 1 500 members and guests at the Annual Dinner of The Institution, at which the Rt. Hon. Sir Oliver Franks was the principal speaker.

'The new Electrical Power Collection at the Science Museum was opened by Viscount Hailsham last Monday afternoon, and I should like to take this opportunity of expressing our appreciation for the help given by the supply and manufacturing sides of the industry and by the Government, which made this new collection possible.

* May 1957, p. 287.

'Here I should like to say a rather special word about The Institution's building. As mentioned in paragraph 24 of the Report, the Joint Building Sub-Committee of the Finance and General Purposes Committees has carried out a prolonged examination of the best means by which The Institution's imperative needs for increasing accommodation could be provided. The possibility of a complete rebuilding, either on the present site or elsewhere, was first thought to be the ideal method of providing a long-term answer to the problem. It became clear, however, that present-day costs ruled out any such major project. Accordingly, modification of the present building was the only feasible alternative. By such means, it has been found that provision could be made for a larger Lecture Theatre, a second meeting room and the extension of other public rooms and of the reception offices.

'The Council this afternoon approved a scheme submitted by the Institution architects for altering the building on the above lines, and this will be placed before a Special General Meeting of Corporate Members and Associates to be held on the 27th June, when proposals for meeting the cost of the work will be reported. There will then be a full opportunity for discussing these plans, and I hope that as many of you as possible will be present at that meeting.'

Sir Gordon then showed three slides illustrating the proposed ground-floor plan and appearance of the building; the architects' drawings of two of these were published in the June *Journal*, p. 354. The President continued:

'Section D deals with activities carried out jointly with other bodies. Perhaps the more important events in this field were the visit to the Soviet Union of the team concerned with engineering education and the corresponding return visit of a Russian team last October. The hard work put in by the organizations mentioned in this Section should not be overlooked, as our co-operation with them plays a major part in furthering the interests of electrical science and engineering in national and international affairs.

'The Government's Report on Scientific and Engineering Manpower in Great Britain has been carefully studied, and measures are being taken to stimulate recruitment to the profession, particular attention being paid to the need to interest girls as well as boys in order to meet the country's future requirements.

'In this connection, the Council have observed with satisfaction the progress being made by the National Council for Technological Awards under the chairmanship of Lord Hives, and they welcome the decision to make a separate award in engineering studies designated Dip.Tech.(Eng.) to distinguish it from Dip.Tech.—the award applicable to other technologies.

'The showing of our Institution film *The Inquiring Mind* has been very successful. It has been well received in numerous public and grammar schools and at several

careers exhibitions in this country. In addition, it has been shown at various centres in Commonwealth countries.

'I should also like to draw attention to the work of the Joint Committee on Practical Training. Their report on the training of graduates was published in January and the supplementary report on training through student apprenticeship is being prepared. The smaller firms will be particularly interested in the suggestions made for developing co-operative and group training schemes, which have a major part to play in the technical education of our future engineers.

'Section F gives much interesting information about the use being made of the Institution Library and of the facilities it offers to members. It also includes statistics which show a further increase in the total papers published in the *Proceedings*. The expansion of Part C is worthy of comment. The *Journal* in its new format is still being well received. Minor changes have been made from time to time and a readers' survey will be made this year to ascertain which items are most popular and to seek suggestions for further improvements.

'Section G concerns the Benevolent Fund. I am sure that all of you will note with regret the decrease in subscriptions and donations which occurred last year for the first time. The increasing membership of The Institution should ensure a steadily increasing rate of subscription, and I would earnestly support the appeal of the Court of Governors for non-subscribing members to look at this again and to support the Benevolent Fund of our own profession.'

The President then proposed the adoption of the Annual Report; the motion was seconded by **Mr. W. Holttum** and was then thrown open to discussion.

Mr. L. W. Phillips remarked with satisfaction on the absence of an organization chart in the Annual Report, saying that for many years there had been a page devoted to tombstones inscribed to the memory of the various bodies with which The Institution was connected. Later, becoming less sad, members had had a document showing the organization of The Institution (more like a Hampton Court maze), while last year there was only the bare skeleton of what was once a corporate body. He hoped that The Institution had passed the age of gloom, through the skeleton in the cupboard to the age of joy and freedom.

Mr. Phillips expressed appreciation of the Electrical Power Collection at the Science Museum and suggested that similar exhibitions should be opened at centres such as Birmingham and Manchester as an inducement to young people to join the electrical industry. He was unhappy about the introduction of the qualification 'Dip.Tech.(Eng.)'—a curious phrase which he thought would not mean very much to people.

He noted that of a membership of 41 522 there were only 72 women, a number he would like to see increased, and he hoped one day to see women on the Council and perhaps a lady in the President's chair. He thought that insufficient advantage was taken of the Specialized Sections, owing to their activities not being well known. On the question of Local Centres he felt that London was so large that it would be helpful to have centres at districts such as Enfield.

Moving to deeper topics, Mr. Phillips reminded members of their responsibilities to society. When engineers choose sites for atomic energy stations without regard to the amenities they are destroying, when they run transmission lines which spoil the beauty that existed before, when television and radio occupy people's time with trivialities, the responsibility was theirs. Nowadays, such things were not regarded from the moral or spiritual point of view but purely from one of political expediency. He called for the setting up of a committee of The Institution to impress on members the need for high integrity and a sense of responsibility for what is happening in the world. He emphasized the need for members, as professional men, to set an example to the country by refusing increases in salary, and by asking only that they may serve to the utmost.

Mr. Phillips ended by expressing his thanks to the Council, the Secretary and the Institution staff.

Sir Gordon Radley, in reply, thought that there was no need for him to say very much, because Mr. Phillips had spelled out many things that were in the Report. However, he assured all members that the absence of an organization chart did not imply a state of disorganization within The Institution. He took note of Mr. Phillips' suggestion that exhibitions should be arranged in large provincial cities, and agreed that The Institution must do more to interest girls in the engineering profession, if simply for the reason that there were not enough men to meet requirements. As far as Local Centres in London were concerned, Sir Gordon said that the Council had considered the position very fully, and though they had not seen fit to recommend any changes at the present time, they would keep such points in mind.

Remarking on Mr. Phillips' more philosophical theme, Sir Gordon was sure that all members felt very conscious of the responsibilities that rest upon the electrical engineer, and he reiterated his remarks made at the Annual Dinner that wisdom must emerge hand in hand with increasing technical knowledge. But such matters as refusing salary increases lay in a field that the Council were not allowed to enter because of the Royal Charter.

Professor J. T. MacGregor-Morris said that he could not hope to rise to the flights of imagination of Mr. Phillips, and that he wanted to localize his remarks on two points. One was the hardy annual of the acoustics of the Lecture Theatre and the other was education. The hall was a bad one for acoustics and though it had certainly been improved by 'these extraordinary looking pillars', he felt that The Institution was responsible for telephony and its applications and that members therefore had a right to expect the very best that could be provided. Regarding education, he said that a lot of time had been devoted to the subject, and why the poor little education body should be called a Circle he did not know. It was time it was promoted to a Section.

The President complimented Professor MacGregor-Morris on the exceedingly clear delivery of his remarks, which had overcome the deficiencies of the theatre. He gave his assurance that the Council were well aware of the acoustic properties of the hall, and that when they came to look at the plans and proposals for the extension of the theatre, an improvement of that kind would be right at the top of the list of priorities. The reason why education was a Circle and not a Section was that it spread over the whole of our specialized interests as engineers.

Mr. W. Holttum raised the matter of refreshments provided before meetings. Not everybody may like sandwiches, in which event a diet of cake was perhaps a rather doubtful luxury, and he made the specific suggestion that the menu should be extended by the addition of some brown bread and butter and buttered scones. The President promised to take note of the suggestion.

Mr. Puttick commented on the furnishing of the Common Room and the Library. In the former the seats induced slumber; in the latter discomfort. The President said that it would be borne in mind, and the Council would try to hit the happy medium.

He then put to the meeting that the Annual Report be received and adopted, and the motion was carried unanimously.

Sir Gordon then asked Viscount Falmouth, Honorary Treasurer of The Institution, to present the Statement of Accounts for the year ended the 31st December 1956.

Lord Falmouth said: 'The members of The Institution will, I am sure, remember that, at a Special General Meeting held on the 22nd March 1956, they were advised that a deficit of £19 000 was estimated for the year 1956. At the same time, the printing trades dispute remained unsolved, and the final settlement raised still further the already heavy printing costs.

'In July 1956 the Finance Committee reviewed the estimates for the year and reported to the Council that the deficit for the year would be £22 500. You will see from the balancing entry at the foot of p. 3 of the Accounts that the final deficit incurred was £23 049. You will notice, too, that we had a balance in the General Reserve Fund of £15 634 which was used to meet part of the deficit, and the remainder, namely £7 415, had to be met from the surplus of assets over liabilities, which, of course, is our capital account.

'The next heading of expenditure, namely the Institution building, shows an apparent decrease of £3 000 during the year 1956, but a word of warning is necessary here. The decrease is accounted for by the fact that rates due for the first nine months of the year have not been paid pending a settlement of The Institution's claim for statutory relief under Clause 8(2) of the 1955 Act. They have, however, been reserved in the Accounts, and at the end of the expenditure, on p. 3, you will find an item, "Reserve for Contingencies, £3 672". This is the answer to the apparent saving.

'The next big item of expenditure covers the *Journal* and *Proceedings*, and there is a net increase in expenditure of £8 300 for the year. As you know, a substantial increase in the printed-paper postage rates operated from the end of 1955, and this has caused the cost of distributing these publications to rise by two-thirds to over £15 000 in 1956. There has been a small increase in paper costs, and printing charges were advanced by 20% in June last. It is fortunate that receipts from the *Journal* and *Proceedings*—subscriptions, sales and advertisements—increased by £5 000 during last year, which offset some of the above increases, leaving the net figure which I have already quoted.

'I do not think that any other item under the heading of expenditure on p. 3 calls for comment, and there is only one point to mention about income. The sales of "Model General Conditions", "Regulations for the Electrical Equipment of Ships" and the Wiring Regulations continued to produce a valuable income during 1956, but of course the market for the 13th Edition of the last publication has now very largely been satisfied, and this source of income will be reduced in future years.

'You will observe that the Building Reserve Fund has again been credited through the year with income from investments held by the Fund, but you will also notice that the securities held by this Fund of £222 365 had a market value at the end of the year of a little over £184 000. This, of course, is a paper loss, unless these securities are sold. There has been a little improvement in the market since the end of the year. You will also observe that the Reserve Fund for Depreciation of Institution Building and Lease, which is shown in the balance sheet as the surrender value of the Sinking Fund policies, has now reached £25 347. The market value of these policies to-day is considerably higher, because these policies will produce £75 000 when they fall in, in 1984, which is only twenty-seven years ahead.

'Perhaps I might mention, in closing, that we are not yet out of the forest of inflation, and that, although the higher membership subscriptions payable in 1957 will considerably increase The Institution's revenue, the surplus we can anticipate at the end of this year will not be a large one.'

Sir Gordon Radley proposed and **Mr. F. Seddon** seconded that the Accounts be received and adopted. The motion was carried unanimously.

Mr. C. J. O. Garrard proposed: 'That the best thanks of The Institution be accorded to the Honorary Secretaries of the Local Centres and Oversea Branches and Committees for their valuable services during the past year.' The resolution was seconded by **Mr. G. V. Sadler,** and carried with acclamation.

A vote of thanks to the Honorary Treasurer was proposed by **Mr. S. E. Goodall** and seconded by **Col. B. H. Leeson.**

Messrs. Allen, Attfield and Co. were reappointed auditors for 1957–58.

The meeting was closed, and members then heard a lecture by **Dr. A. D. Booth** on 'General Applications of Digital Computers'.

ACCOUNTS FOR 1956

Income and Expenditure Account for the Year ended 31st December 1956

EXPENDITURE

Year ended 31 Dec., 1955		£	£	£
	MANAGEMENT:			
	Salaries, Wages and National Insurance	76,956		
	Staff Provident Scheme	6,094		
	Staff Canteen Subsidies	596		
	Printing, Stationery and Office Requisites	9,666		
	Postage of Correspondence and Notices	3,873		
	Telephone	1,184		
	Travelling Expenses	3,625		
			101,994	
	Less Charged to 'SCIENCE ABSTRACTS'		3,465	
88,699				98,529
	INSTITUTION BUILDING:			
	Ground Rent		2,201	
	Rates		2,415	
	Heating		3,196	
	Lighting and Power		1,146	
	Insurance		491	
	Household Requisites and Cleaning		3,743	
	Transferred to Repairs Suspense Account		3,000	
			16,192	
	Less Rents from Tenants	6,753		
	Charged to 'SCIENCE ABSTRACTS'	946		
			7,699	
11,512				8,493
2,477	FURNITURE AND FITTINGS (Repairs and Renewals)			912
	JOURNAL AND PROCEEDINGS:			
	Printing		39,610	
	Paper		26,536	
	Postage		15,290	
	Wrappers and Envelopes		1,312	
			82,748	
	Less Subscriptions	14,328		
	Sales and Advertisements	31,137		
			45,465	
28,902				37,283
2,322	STUDENTS' QUARTERLY JOURNAL (Editing, Printing, Postage, etc.: *less* Sales)			2,316
344	LENDING LIBRARY (Books, Printing, Postage, etc.)			449
	'SCIENCE ABSTRACTS':			
	Block Contribution		2,746	
	Per Capita		1,900	
4,099				4,646
	INSTITUTION MEETINGS:			
	Advance Proofs		1,219	
	Reporting		458	
	London Students' Section		468	
	Kelvin and Section Lectures		185	
	Refreshments, Assistance, etc.		970	
	Travelling Expenses of Authors of Papers		138	
	District Meetings		127	
3,357				3,565
	CONVENTIONS:			
	Thermionic Valve Jubilee—Volume		—	
	Digital-Computer Techniques		1,157	
	Electricity in Aircraft		810	
	Ferrites		238	
611				2,205
	LOCAL CENTRES:			
	Administration and Meetings Expenses		13,384	
	Travelling Expenses		381	
	Students' Lectures		152	
13,369				13,917
155,692			CARRIED FORWARD	172,315

EXPENDITURE—*contd.*

£		£	£
155,692	BROUGHT FORWARD		172,315
	OVERSEA BRANCHES:		
	Administration Expenses	2,284	
	Loss on Exchange on remittances to London	689	
2,213			2,973
1,667	FARADAY AND CHILDREN'S LECTURES		1,662
444	PREMIUMS FOR PAPERS, ETC.		423
1,470	SCHOLARSHIPS, provided from Institution Funds		1,575
	GRANTS:		
	Electrical Research Association	500	
	British Standards Institution	250	
	C.I.G.R.É.	75	
	Others	108	
951			933
	CONFERENCES:		
	British Electrical Power Convention	22	
	British Nuclear Energy Conference	—	
	Conference of Engineering Societies of Western Europe and U.S.A.	296	
	Conference of Engineering Societies of the Commonwealth	—	
816			318
500	CONTRIBUTION TO FILM 'THE INQUIRING MIND'		—
323	ANNUAL DINNER		570
473	AUDIT FEE		473
315	LEGAL EXPENSES		298
—	CONVERSAZIONE		937
—	SPEAKING PORTRAITS		71
3,371	MISCELLANEOUS EXPENSES		3,664
8,230	TRANSFER TO REBUILDING RESERVE FUND		8,343
278	TRANSFER TO SINKING FUND (PREMIUMS for Redemption of Cost of Building and Lease)		278
	RESERVE FOR CONTINGENCIES		3,672
	DEPRECIATION:		
	Library	658	
	Furniture, Fittings and Equipment	1,199	
1,566			1,857
£178,309			£200,362

INCOME

Year ended 31 Dec., 1955				
£		£	£	£
138,891	SUBSCRIPTIONS			142,929
4,464	ENTRANCE FEES			5,501
—	LIFE COMPOSITIONS			663
8,230	INTEREST ON INVESTMENTS			8,343
456	DEPOSIT INTEREST			389
1,648	MEMBERS' SUBSCRIPTIONS TO 'SCIENCE ABSTRACTS'			2,194
8,802	SALES OF 'MODEL GENERAL CONDITIONS', 'WIRING REGULATIONS', 'SHIP WIRING REGULATIONS' and 'HISTORY OF THE INSTITUTION'			6,981
	EXAMINATIONS:			
	Institution Examination (Candidates' Fees and Sale of Papers)	14,166		
	Less Examiners' Fees, Printing, etc. (but excluding cost of Administration and Overhead Expenses, approx. £8,830)	8,612		
	National Certificates and Diplomas (Candidates' and School Authorities' Fees)	10,972	5,554	
	Less Assessors' Fees, Stationery, Postage, Travelling Expenses, etc. (but excluding cost of Administration and Overhead Expenses, approx. £4,850)	6,649		
			4,323	
10,737				9,877
715	SALES OF CONVENTION PROCEEDINGS			436
173,943				177,313
	EXCESS OF EXPENDITURE OVER INCOME TRANSFERRED TO:—			
4,366	GENERAL RESERVE FUND		15,634	
—	SURPLUS OF ASSETS OVER LIABILITIES		7,415	
				23,049
£178,309				£200,362

Balance Sheet, 31st December 1956

	£	£
CREDITORS		49,542
SUBSCRIPTIONS, ETC., RECEIVED IN ADVANCE		14,367
REBUILDING RESERVE FUND:		
Balance at 1st January, 1956	214,002	
Add Transfer from Income and Expenditure Account	8,343	
Gain on Conversion of Securities	20	
		222,365
GENERAL RESERVE FUND:		
Balance at 1st January, 1956	15,634	
Less Part Excess of Expenditure over Income transferred	15,634	—
RESERVE FOR CONTINGENCIES		3,672
RESERVE FUND FOR DEPRECIATION OF INSTITUTION BUILDING AND LEASE, BEING SURRENDER VALUE OF SINKING FUND POLICIES		25,437
REPAIRS SUSPENSE ACCOUNT:		
Balance at 1st January, 1956	4,937	
Amount reserved in 1956.	3,000	
	7,937	
Less Expenditure on Repairs in 1956	4,053	
		3,884
Surplus of Assets over Liabilities:—Balance at 1st January, 1956	78,313	
Less Balance of excess of Expenditure over Income transferred	7,415	
		70,898
		£390,165

	£	£
INSTITUTION BUILDINGS AND LEASE (at cost)		69,631
SINKING FUND (Surrender Values of Policies for Redemption of Cost of Building and Lease)		25,437
LIBRARY (exclusive of the Ronalds Library and Faraday Papers, which are held in trust, but inclusive of Thompson Library):		
As per last Balance Sheet	6,211	
Additions in 1956	1,362	
	7,573	
Less Depreciation at 10% (excluding Thompson Library).	658	
		6,915
FURNITURE, FITTINGS AND EQUIPMENT:		
As per last Balance Sheet	19,298	
Additions in 1956	1,083	
	20,381	
Less Depreciation	1,199	
		19,182
DEBTORS		12,163
INSURANCE PREMIUMS AND SUNDRY PAYMENTS IN ADVANCE		3,138
STOCKS OF STATIONERY AND PAPER		13,413
REBUILDING FUND. INVESTMENTS (at cost):		
British Government Securities	125,190	
British Municipal Securities	32,720	
Dominion and Colonial Government Securities	40,567	
Public Boards and Trade Facilities Stocks	9,798	
Debenture Stocks	14,090	
(*Market value 31st December, 1956*, £184,143)		222,365
GENERAL FUND INVESTMENTS. INVESTMENTS (at cost):		
British Government Securities		13,852
(*Market value 31st December, 1956*, £12,120)		
CASH IN HANDS OF LOCAL CENTRES ON 31ST DECEMBER, 1956		1,987
CASH IN HANDS OF OVERSEA BRANCHES ON 31ST DECEMBER, 1956		1,238
CASH IN HANDS OF SECRETARY		443
CASH AT BANK		401
		£390,165

FALMOUTH, *Honorary Treasurer.* W. K. BRASHER, *Secretary.*

Report of the Auditors to the Members of The Institution of Electrical Engineers

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit. In our opinion proper books of account have been kept by The Institution so far as appears from our examination of those books. We have examined the above Balance Sheet and annexed Income and Expenditure account which are in agreement with the books of account. In our opinion and to the best of our information and according to the explanations given us the said accounts are properly drawn up and the Balance Sheet gives a true and fair view of the state of the Institution's affairs as at 31st December, 1956, and the Income and Expenditure account gives a true and fair view of the excess of Expenditure over Income for the year ended on that date.

7th March, 1957

ALLEN ATTFIELD & CO., *Chartered Accountants*, 24 Martin Lane, Cannon Street, E.C.4.

BLUMLEIN-BROWNE-WILLANS PREMIUM FUND

	£ s. d.		£ s. d.
Capital Account	700 0 0	Investment (at cost): £686 10s. 0d. British Electricity 4¼% Stock (1974–79)	700 0 0
	£700 0 0		£700 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Premiums awarded	40 0 0	By Balance (as per last Account)	58 7 0
„ Balance carried to Balance Sheet	47 10 6	„ Interest received	29 3 6
	£87 10 6		£87 10 6

WILLIAM BEEDIE ESSON SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,808 12 6	Investments (at cost):	
		£1,755 15s. 6d. 3½% War Stock	1,853 2 6
		£200 New Zealand 3½% Stock (1963–66)	200 0 0
		£100 East Africa High Commission 3½% Stock (1966–68)	97 10 0
		£400 British Electricity 3½% Stock (1976–79)	396 0 0
		£250 Birmingham Corporation 2½% Stock (1966–71)	250 0 0
		Cash	12 0 0
	£2,808 12 6		£2,808 12 6

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance (as per last Account)	18 1	By Interest received	91 14 0
„ Amount paid to Scholars	210 0 0	„ Balance carried to Balance Sheet	119 4 1
	£210 18 1		£210 18 1

WILLIAM GEIPEL SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	£1,292 18 1	Investment (at cost): £1,583 11s. 10d. 3½% War Stock	1,292 18 1
	£1,292 18 1		£1,292 18 1

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	12 10 0	By Balance (as per last Account)	27 14 3
„ Balance carried to Balance Sheet	73 14 10	„ Interest received	58 10 7
	£86 4 10		£86 4 10

DAVID HUGHES SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,000 0 0	Investment (at cost): £2,045 Metropolitan Water Board (Staines Reservoirs) 3% Guaranteed Debenture Stock (1922 or after)	1,998 15 0
		Cash	1 5 0
	£2,000 0 0		£2,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	144 9 0	By Balance (as per last Account)	83 2 0
		„ Interest received	61 7 0
	£144 9 0		£144 9 0

I.M.E.A. SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	15,202 0 11	Investments (at cost):	
		£5,965 5s. 10d. 3½% War Stock	5,965 5 10
		£4,500 3% Savings Bonds (1960–70)	4,500 0 0
		£1,867 0s. 9d. British Electricity 3% Stock (1974–77)	1,736 15 1
		£1,000 Bristol Corporation 3½% Stock (1961–66)	1,000 0 0
		£1,000 Coventry Corporation 3½% Stock (1960–64)	1,000 0 0
		£1,000 Paisley Corporation 3½% Stock (1958–60)	1,000 0 0
	£15,202 0 11		£15,202 0 11

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	420 0 0	By Balance (as per last Account)	277 10 8
„ Balance carried to Balance Sheet	372 7 9	„ Interest received	514 17 1
	£792 7 9		£792 7 9

JOHN DOUGLAS KNIGHT AND ELIZABETH DUNCAN KNIGHT FUND

	£ s. d.		£ s. d.
Capital Account	980 2 9	Investments (transferred):	
		£333 6s. 8d. 3% Savings Bonds (1960–70)	333 6 8
		£624 9s. 6d. 3½% Conversion Stock	624 9 6
		Cash	22 6 7
	£980 2 9		£980 2 9

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance carried to Balance Sheet	49 5 0	By Balance (as per last Account)	17 8 0
		„ Interest received	31 17 0
	£49 5 0		£49 5 0

SIR EDWARD MANVILLE SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	5,000 0 0	Investment (at cost):	
		£5,000 3% Savings Bonds (1955–65)	5,000 0 0
	£5,000 0 0		£5,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Balance (as per last Account)	20 4 4	By Interest received	150 0 0
„ Amount paid to Scholar	150 0 0	„ Balance carried to Balance Sheet	20 4 4
	£170 4 4		£170 4 4

HENRY NIMMO PREMIUM FUND

	£ s. d.		£ s. d.
Capital Account	150 0 0	Investment (at cost):	
		£253 8s. 11d. 2½% Treasury Stock (1975 or after)	150 0 0
	£150 0 0		£150 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Premium Award	10 0 0	By Interest received	6 6 8
		„ Transfer to Premiums Account	3 13 4
	£10 0 0		£10 0 0

HENRY NIMMO PRIZE FUND

	£ s. d.		£ s. d.
Capital Account	500 0 0	Investment (at cost): £564 1s. 3d. British Electricity 4¼% Guaranteed Stock (1974–79)	500 0 0
	£500 0 0		£500 0 0
INCOME ACCOUNT			
To Balance carried to Balance Sheet	£11 19 8	By Interest received	£11 19 8

PAGE PRIZE FUND

	£ s. d.		£ s. d.
Capital Account	100 19 5	Investments (at cost): £50 3½% War Stock	50 19 5
		£56 4s. 5d. British Electricity 3% Guaranteed Stock (1968–73)	50 0 0
	£100 19 5		£100 19 5
INCOME ACCOUNT			
To Award of Prize	6 3 0	By Balance (as per last Account)	5 2 8
„ Balance carried to Balance Sheet	2 8 4	„ Interest received	3 8 8
	£8 11 4		£8 11 4

SIR CHARLES A. PARSONS MEMORIAL SCHOLARSHIP

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	15 0 0	By Balance brought forward	98 9 6
„ Balance as per Bank Account	134 17 0	„ Interest received	51 7 6
	£149 17 0		£149 17 0

NOTE.—The Capital of this Fund is invested by the Charity Commission.

PAUL SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	4,000 0 0	Investments (at cost): £3,019 3s. 7d. 3½% Funding Stock (1999–2004)	3,000 0 0
		£625 4% Funding Stock (1960–90)	500 0 0
		£562 4s. 7d. British Electricity 3% Guaranteed Stock (1968–73)	500 0 0
	£4,000 0 0		£4,000 0 0
INCOME ACCOUNT			
To Amount paid to Scholars	86 10 0	By Balance (as per last Account)	177 15 5
„ Balance carried to Balance Sheet	238 16 1	„ Interest received	147 10 8
	£325 6 1		£325 6 1

SALOMONS SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	2,044 15 4	Investment (at cost): £2,485 10s. 7d. Commonwealth of Australia 3% Stock (1972–74)	2,044 15 4
	£2,044 15 4		£2,044 15 4
INCOME ACCOUNT			
To Amount paid to Scholar	15 0 0	By Balance (as per last Account)	135 5 0
„ Balance carried to Balance Sheet	194 16 4	„ Interest received	74 11 4
	£209 16 4		£209 16 4

SWAN MEMORIAL SCHOLARSHIP FUND

	£ s. d.		£ s. d.
Capital Account	3,312 15 10	Investments (at cost):	
		£905 10s. 4d. 3% Savings Bonds (1960–70)	995 0 6
		£1,200 British Electricity 3½% Stock (1976–79)	1,194 4 0
		£1,135 17s. 9d. 3½% Conversion Stock (1961 or after)	1,123 11 4
	£3,312 15 10		£3,312 15 10

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholar	90 0 0	By Balance (as per last Account	339 0 1
„ Balance carried to Balance Sheet	357 18 7	„ Interest received	108 18 6
	£447 18 7		£447 18 7

THORROWGOOD SCHOLARSHIP TRUST FUND

	£ s. d.		£ s. d.
Capital Account	1,000 0 0	Investment (at cost):	
		£1,005 Agricultural Mortgage Corporation 5% Debenture Stock (1959–89)	1,000 0 0
	£1,000 0 0		£1,000 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	60 0 0	By Balance (as per last Account)	97 14 11
„ Balance carried to Balance Sheet	87 19 11	„ Interest received	50 5 0
	£147 19 11		£147 19 11

WAR THANKSGIVING EDUCATION AND RESEARCH FUND (No. 1)

	£ s. d.		£ s. d.
Capital Account	1,700 0 0	Investment (at cost):	
		£2,000 3½% War Stock	1,700 0 0
	£1,700 0 0		£1,700 0 0

INCOME ACCOUNT

	£ s. d.		£ s. d.
To Amount paid to Scholars	75 0 0	By Balance (as per last Account)	131 5 0
„ Balance carried to Balance Sheet	126 5 0	„ Interest received	70 0 0
	£201 5 0		£201 5 0

WILDE BENEVOLENT TRUST FUND

	£ s. d.		£ s. d.
Capital Account	3,048 10 2	Investments (at cost):	
		£1,397 18s. 6d. British Transport 3% Guaranteed Stock (1978–88)	1,744 3 11
		£100 London County 2¾% Consolidated Stock (1960–70)	101 8 6
		£250 Commonwealth of Australia 3% Stock (1972–74)	250 0 0
		£500 3½% War Stock	501 9 3
		£381 15s. 1d. 4% Funding Stock (1960–90)	300 0 0
		£200 3½% Conversion Stock (1961 or after)	151 8 6
	£3,048 10 2		£3,048 10 2

INCOME ACCOUNT

	£ s. d.	£ s. d.		£ s. d.
To Grant authorized		104 0 0	By Balance (as per last Account)	41 0 10
„ Balance—Deposit Account	27 3 1		„ Interest received	93 5 11
Tax Recoverable	3 3 8			
		30 6 9		
		£134 6 9		£134 6 9

APPLIED NUCLEAR RESEARCH IN CAITHNESS

Britain's Atomic Energy Establishment at Dounreay takes shape

Introduction to Dounreay

ALMOST all those who read this will have heard of Dounreay. It is one of those slightly emotional names which, like Windscale, Capenhurst, Calder Hall, Chapel Cross and Bradwell-on-Sea, have become part of Britain's newest industrial geography—the geography of nuclear energy activity. The new works there of the United Kingdom Atomic Energy Authority received a fanfare of Press publicity two months ago. But despite this, some engineers who have not been to Caithness may yet have a feeling that Dounreay is merely a temporary site for testing a not absolutely safe reactor. The truth is different; the Dounreay works, colourful, exciting and inaccessible, are a full-scale research centre of the U.K.A.E.A.'s Industrial Group, and they are the first industrial works of any size in the far north of Scotland. Sir Christopher Hinton has emphasized that their purpose is research and not manufacture, and in this they differ from other works of the Industrial Group such as Capenhurst and Calder Hall. On the basis of present plans, Dounreay will provide employment for about 1 350 people by April 1958.

The station, which is laid out on a former naval airfield, is now about two-thirds completed, and trials of some equipment are in progress. What then is to be seen there? There is, of course, the giant globe housing the fast breeder reactor (Fig. 1), a structure that has become symbolic of Dounreay. Although 135 ft in diameter, it does not architecturally dominate the site as much as one might suppose from photographs, for it rests virtually on the ground; moreover it will be flanked by a heat-exchanger house and by a fuel-storage building and chimney.

Besides the fast reactor and its associated plant for electrical-power generation and for fuel handling and storing, a second reactor known as DMTR (Dounreay Materials Testing Reactor), is being built on the site. This reactor, similar to DIDO and PLUTO at Harwell,

1 *The steel sphere housing the fast breeder reactor at Dounreay*

To the left of the picture are the heat-exchanger and Diesel-generator houses. To the right are an administration building and the framework of the element storage building, which contains the lift leading to the cylindrical air-lock entry to the sphere.

uses enriched fuel and is moderated and cooled by heavy water. It will enable tests of irradiated materials, of direct use in the design of fast reactors, to be carried out at high neutron fluxes. DMTR's protective shield is a squat steel cylinder, 70 ft in both diameter and height. Associated with DMTR are buildings equipped for making 'test rigs' of materials to be irradiated, and for handling active materials; small cooling towers will dissipate the heat generated by the reactor, after it has been passed through a heat exchanger from the heavy-water to a light-water cooling circuit.

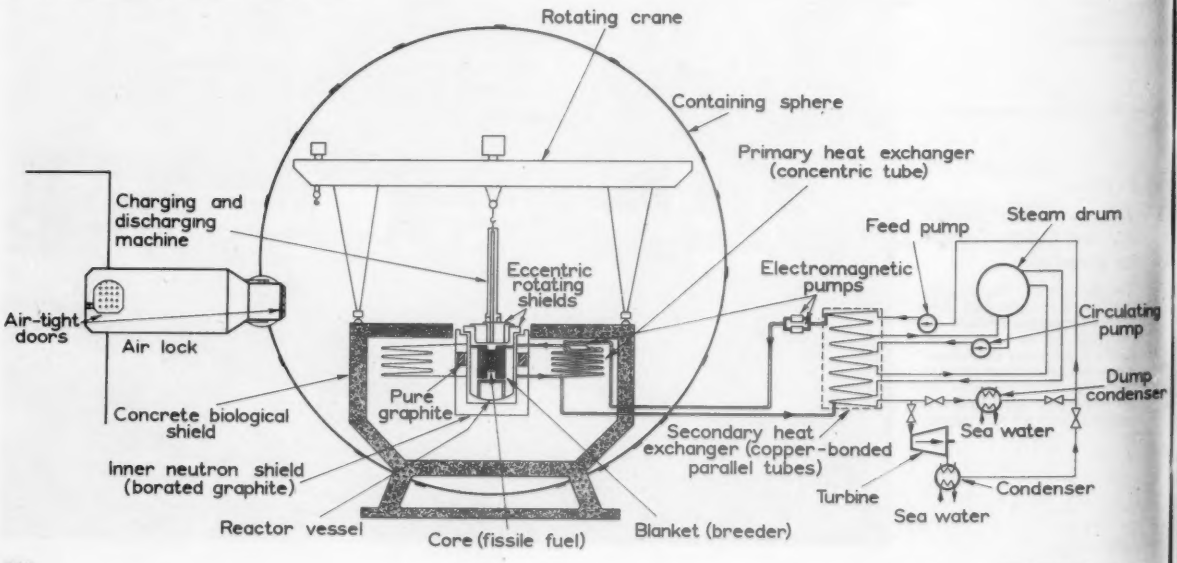
But the Dounreay works comprise more than the two reactors and their complementary equipment. There is a large group of chemical buildings, which includes laboratories, plant for producing uranium billets, fabricating fuel elements, and processing irradiated fuel, and capacious subterranean tanks for storing highly active effluents. The health physics section, housed in a splendidly equipped building, is a familiar unit in atomic energy establishments: at Dounreay it is provided with specially fitted Land Rovers for measuring radioactivity in the surrounding country. More unusual are the half-mile tunnel below the Pentland Firth for discharging moderately active liquids, and the sea-water pump-house for providing cooling water, with its zig-zag intake channel cut deep into the rock. One cannot long forget the sea at Dounreay.

Dounreay's Purpose

Dounreay will become a full-scale industrial research establishment equipped for varied investigations, but its primary purpose lies in experiments with the fast breeder reactor. The protective steel sphere, at present gaunt and problematical in appearance, may lack the physical domination of the dome of St. Paul's or St. Peter's, Rome; but unquestionably it dominates Dounreay psychologically. No one who works at or visits this strange industrial site on the very edge of Scotland can miss realizing that the fast reactor is the heart of the whole enterprise. When the reactor (why does not the U.K.A.E.A. give it a name?) is brought up to full power next year, he will be an unemotional man of Dounreay who is not at least a little excited.

Two disadvantages of the gas-cooled graphite-moderated type of reactor, used at Calder Hall and in Stage I of the C.E.A. nuclear power programme, are its low heat output per unit volume of nuclear fuel and the fact that the plutonium it produces cannot be recycled as a fuel in the reactor. At present the demand for plutonium for military purposes removes any difficulty in selling the plutonium produced by a Calder-Hall-type reactor. The Atomic Energy Authority estimates that in the mid-nineteen-sixties the supply of plutonium in Britain will overtake the demand. To preserve the economy of nuclear power generation, it will thus become essential to be able to use the plutonium itself as a nuclear fuel, and one way to do this is to use a fast reactor (i.e. using fast neutrons to cause fission). Moreover a fast liquid-metal-cooled reactor is inherently a more efficient furnace for using a nuclear fuel than a gas-cooled reactor using slow (thermal) neutrons, for it can permit a higher heat-transfer rate and it has no moderator causing useless neutron absorption. In addition, by including in the fuel of a fast reactor some fertile material (e.g. uranium 238 or thorium 232, which can by neutron irradiation become fissile), one can ensure an output of fissile material (e.g. plutonium or uranium 233) greater than the original amount with which the reactor is charged and which is 'burnt' in the process of generating heat. In a fast reactor the fissile fuel may be uranium 235, plutonium, or

2 *A schematic of the fast-reactor plant*



uranium 233. Neither plutonium nor uranium 233 is readily available in sufficient quantity for use in the Dounreay reactor. Hence the fuel at first will be uranium 235, or, more accurately, natural uranium lavishly enriched with uranium 235, which is produced by the gaseous diffusion plant at Capenhurst in Cheshire. Since uranium 235 is very expensive to produce, later experiments will use plutonium, when it is available.

Although the Dounreay fast reactor will produce enough heat to drive a 15 MW turbo-generator, its purpose is experimental. The Atomic Energy Authority is looking ahead to the time when it becomes imperative to use plutonium as a power-producing fuel. Even if fast reactors were fully engineered in this country at present, they could not be used commercially for generating electrical energy since plutonium is not available and uranium 235 is not economic. In the United States the situation is somewhat different.

The high heat rating of a fast reactor demands a liquid-metal coolant. For various reasons an alloy of sodium and potassium has been chosen for initial use in the Dounreay reactor. The liquid metal is pumped through one heat exchanger inside the reactor itself, a secondary liquid sodium-potassium circuit taking the heat

3 *Work in progress on the fast reactor, January 1957*

The photograph shows the top surface of the reactor vault just below the equatorial plane of the containing sphere. Work was proceeding at the time on the installation of the core-supporting structure, the 24 heat-exchanger banks and the 24 electromagnetic pumps. The reactor vessel shown in Fig. 4 was not then in position.

4 *Hoisting the 45-ton stainless-steel reactor vessel into the fast reactor*

The stubs in the vessel to which pipes carry the liquid cooling metal may be seen. The interior is complex, with numerous tubes, pipes and instrument boxes so closely placed that their fabrication demanded special procedures.

to another heat exchanger outside the reactor sphere which generates steam to drive the turbo-generator.

Should the reactor cooling circuits fail completely, it would be possible for the reactor core to melt and even for the coolant to catch fire, though the liquid metal is buffered with helium. Either of these catastrophes could release dangerous fission products into the surrounding atmosphere, but for the steel sphere; this has been designed to withstand an internal pressure of 18 lb/in^2, the calculated maximum pressure of products of combustion in the enormous volume of the sphere. The design of the core makes it impossible for the reactor to become supercritical and explode in the manner of an atomic bomb.

The Fast Breeder Reactor

To appreciate the size of Dounreay's steel sphere one must see inside it. On passing through the sphere's only entry, a cylindrical air lock slightly below the equatorial plane, the change from a convex to a concave view is startling. Impressively void except for a rotating crane, the giant grey steel dome formed by the upper hemisphere is at once protective and frightening, and paint will doubtless give it a touch of splendour.

The reactor occupies the lower half of the sphere (Figs. 2 and 3). The cylindrical stainless-steel reactor vessel (Fig. 4), 20 ft × 14 ft overall, contains the core of fissile, and the blanket of fertile, material. Its double walls are filled with gas as part of the system of leak detection. Its construction is very complicated and took 18 months

5 *The cylindrical steel vessel containing DMTR*

The photograph is taken looking towards the eastern end of the Dounreay site. In front on the left are the cooling towers, and on the right the building for handling active materials and fuel elements. On the extreme left may be seen the north coast of Caithness.

to complete. Eccentric rotating shields at the top of the vessel allow a limited opening to give access to the whole area of the core and blanket. The core itself is of hexagonal section, only 21 inches high and 21 inches across flats, and comprises several hundred tubular fuel elements. These elements are contained in sheaths of niobium, which has a high melting point and is little affected by hot uranium or sodium. Surrounding the core is a blanket of fertile material made up of about 2000 rods 8 ft long, enclosed in stainless-steel cans.

Twelve groups of the fuel elements can be moved in and out of the core to act as control rods. Such control by movement of the core itself differs from that used in most previous reactors, which have been fitted with movable neutron-absorbing rods. When working at its designed output, the reactor will produce heat at the rate of 60 MW, and this will be removed by the liquid sodium-potassium alloy flowing through and around the core tubes and blanket rods. This liquid metal will become radioactive when the reactor is operating, and a primary heat exchanger will pass the heat to a second liquid-sodium-potassium circuit in which the metal can be safely pumped away to the secondary heat exchanger outside the reactor sphere. A neutron shield of borated graphite will prevent the secondary liquid-metal from becoming radioactive. Enclosing this graphite shield and the primary heat exchanger is a concrete biological shield.

To circulate the liquid metal in both primary and secondary circuits, there are 24 electromagnetic pumps in each circuit. These are flat linear induction pumps ('flips'), with flat pump tubes welded to the pumping circuits. Stators can be replaced without any disturbance to the liquid-metal circuits.

The heat-exchanger system is complicated. The primary heat-exchanger uses concentric tubes, while the secondary involves numerous sets of four liquid-metal tubes surrounding one steam tube in a copper matrix. There are twelve independent heat-exchanger units, each unit comprising two primary liquid-metal circuits, one secondary liquid-metal circuit, a steam-raising plant and a dump condenser to take the steam when the turbine is not operating. The electromagnetic pumps in each unit are supplied from a separate Diesel generator. This spread of the reactor heat dissipation among twelve independent units makes a complete failure of the cooling system most improbable.

Situated in a building near the giant sphere is the control room for the fast reactor. From here the operator can instantly shut down the reactor by cutting the supply of current to the hold-on solenoids for the reactor control rods and for some boron safety rods fitted for emergency use. Automatic shut-down takes place if the core temperature rises too high, if the flow of metal coolant through the core and blanket is too low, or if the neutron flux is too great or increasing unusually rapidly. Many instruments such as flowmeters and ion chambers pass quantitative information to the control room.

The twelve Diesel generators supplying the power for the cooling-circuit pumps are rated at 120 kW, 415 volts, 50 c/s. Six standby generators are installed—one for every two in active use. The supply for certain reactor auxiliaries such as heaters, instruments and lighting is taken from the Grid or from the 15 MW generator. Standby 220 kW Diesel generators are also fitted, and batteries are provided for use when changing over from the Grid to Diesel generator. The designers of the fast-reactor system have indeed been—quite rightly—very safety conscious. Evidence of this can be seen in the secondary heat exchanger, with its amazing array of small pipes, whose design is governed by the need for safety rather than efficiency. The plant of this heat exchanger is housed in a separate building adjacent to the reactor sphere and the turbine house. Steam is passed to the turbine at a pressure of 150 lb/in.^{2} and a temperature of 518° F, though it is probable that these steam conditions may be improved when more experience has been gained on the reactor. The heat exchanger is a slave to its reactor rather than its turbine, and excess steam is spilled into dump condensers cooled by sea water, which

are fitted in the turbine house. The alternator will generate at 11 kV and is designed for operating at a power factor of 0·85. Since Dounreay is not to be regarded as a power station, no standby generating set is provided.

The Dounreay Materials Testing Reactor

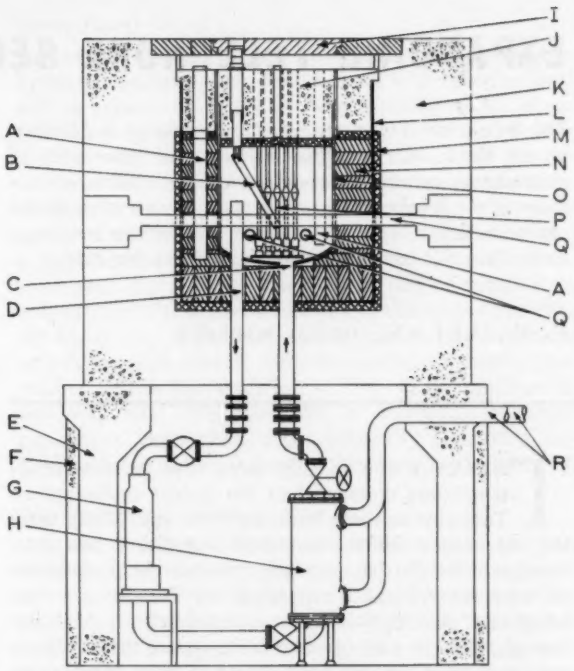
Taking second, but a most important, place in the Dounreay research station is DMTR (Fig. 5). This is almost a replica of DIDO—and even more so of PLUTO—at Harwell, but it permits larger 'test rigs' of materials to be inserted than DIDO itself. Only a few notes about DMTR are given here. It will run on enriched fuel, but is not, of course, a fast reactor; both moderator and coolant are heavy water. Its peak neutron flux is 10^{14} thermal neutrons/cm^2/sec and its heat output 10 MW.

The core of the reactor (Fig. 6) consists of 26 fuel elements, which are surrounded by heavy water in an aluminium tank. The structure of the active part of the elements is interesting, comprising as it does 10 curved plates of aluminium-clad uranium-aluminium alloy, about 25 inches long and only 0·058 inch thick and 0·177 inch apart. To this active part are attached aluminium fittings for locating the element in the reactor core, directing the flow of heavy water and carrying instrument leads and sampling tubes. The elements are fabricated at Dounreay in what will effectively be a production plant for reactor fuel elements, supplying them to other reactors in Britain and oversea. Outside the aluminium tank is a graphite reflector, which is enclosed in a steel tank. A lead shield and concrete walls screen the reactor. Seven coarse control arms, of cadmium and stainless steel, are provided to control reactivity. These are of the 'railway-signal' type and operate downwards from a fully-out horizontal position through a 60° arc. Normally they move slowly, but a fall can be made rapidly to cope with an emergency.

The core requires heavy water at the rate of 4800 gal/min, which is provided by three totally submersible 60h.p. pumps. The light water from the heat exchangers is circulated by four pumps to cooling towers. To make any leaks operate from the heavy to the light water, rather than vice versa, the pressure of the light-water circuit will be kept below that of the heavy-water circuits.

The Future

The real experimental work of Dounreay will not begin before the 1st April 1958, the target date for both reactors to become critical. But there is, of course, already a large and growing staff at the establishment, whose works general manager is Major-General S. W. Joslin, a Member of The Institution. Although the U.K.A.E.A. has so far had little difficulty in recruiting professional scientists and engineers to work at Dounreay, it has not been so easy for them to obtain the craftsmen and technicians, for there is very little skilled labour available locally, and the nearest sizable technical college is at Aberdeen, some 240 miles away by road. A start has been made on a small technical college at Thurso to train boys and girls up to the second-year level of the Ordinary



6 *A simplified vertical section of DMTR*

A	Vertical experimental hole.	J	Aluminium-tank top shield.
B	Coarse control arm.	K	Biological shield.
C	Heavy-water inlet.	L	Reactor steel tank.
D	Heavy-water outlet.	M	Lead shield.
E	Biological shield.	N	Graphite reflector.
F	Lead-shot concrete.	O	Reactor aluminium tank.
G	Heavy-water circulating pump.	P	Fuel elements.
H	Heavy/light-water heat exchanger.	Q	Horizontal experimental holes.
I	Steel top plate.	R	Cooling inlet and outlet.

National Certificate. Schools for the families of those working at Dounreay are another problem, and a new secondary school is being built in Thurso.

The Dounreay works have come—and come to stay. The far North of Scotland now has a growing industrial establishment, which should bring ancillary industry to Caithness as it gets into its stride. Recently a start has been made near the main works at Dounreay on a land-based prototype reactor for H.M.S. *Dreadnought*, Britain's first nuclear-propelled vessel. Although no plans have been announced, it seems likely that, after experience on the fast breeder reactor, the U.K.A.E.A. will wish to build other fast reactors at Dounreay with a view to evolving a prototype for a commercially operated power station. This points to a busy and expanding future, and one which may make the wind-torn stretch of coast to the west of Thurso of cardinal significance in the nineteen-sixties. The Navy no longer uses Scapa Flow, but on the coast overlooking the exercise area of the ships that formerly graced the anchorage, Caithness has won a new activity, as important to Great Britain as the Home Fleet once was. Dounreay's show piece may look externally like a huge bathysphere or even a space ship, but it is built on firm foundations and sound design. Its progress in a year's time will be keenly followed.

EXPANDING TELEPHONE SERVICES ON TEES-SIDE

The decision to build a new telephone exchange in Middlesbrough has given Post Office engineers the opportunity of designing an entirely up-to-date telephone system. An account of the developments taking place there is given in this article, which is based on the author's Chairman's Address to the Tees-Side Sub-Centre on the 3rd October 1956.

F. W. ALLAN, ASSOCIATE MEMBER

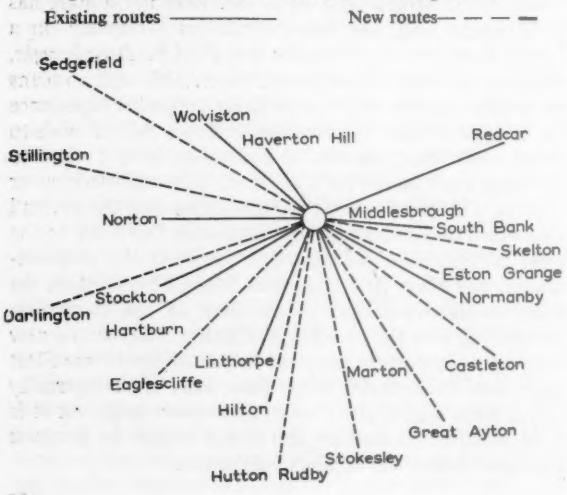
THERE are now in 1956 more than twice as many telephones connected to the public exchanges on Tees-Side as there were ten years ago. Many more will be needed for the industrial expansion now proceeding in the district. As a major item in the programme of telecommunication expansion on Tees-Side, a new telephone exchange is being constructed in Middlesbrough, and the underground cable system there is being enlarged, extended and modernized to provide adequate telephone services for present and future needs. A new building specially designed to house the switching and transmission equipment is nearing completion, and the installation of telephone plant in it has already begun.

Automatic and Manual Switching Plant

The plant when completed (probably during 1958) will include the most modern type of Strowger switchgear to enable all subscriber-to-subscriber calls within a radius of fifteen miles of Middlesbrough to be connected by subscriber dialling without assistance from telephone operators. The increase in subscriber-to-subscriber dialling routes is shown by Fig. 1.

The equipment will in the first place enable service to be given to 5 000 subscribers' lines in Middlesbrough and will be expandable to 8 000 or more in future. There will also be a manually-controlled switching unit for the circulation of calls in both directions between subscribers in the Tees-Side area and every other part of the United Kingdom and all other parts of the world accessible by public-telephone routes. A new repeater station will ensure that speech over the longer circuits is ample and clear.

The manual switchboards are to be a new cordless type, which have so far been installed in only one other public exchange in the United Kingdom, namely the Thanet exchange. Trunk circuits will not be permanently connected to the switchboards as has been the regular practice hitherto. Incoming calls will cause trunks to be temporarily connected to an operator's position, so that they can be extended as required by the operators, who will use simple key switches to control trunk-switching equipment located near to the trunk-cable terminals in the basement of the building. There will be fifty-five operators' positions to replace the seventy-eight now in use in the existing exchange. The cordless switchboard

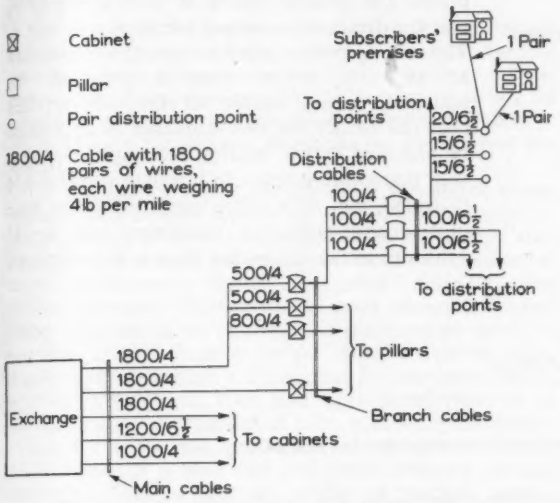


1 *Expansion of subscriber-to-subscriber dialling routes*

2 *Expansion of operators' dialling routes*

Existing routes
Routes to the new exchange

is intended to quicken the setting up of long-distance calls by improving the operators' working conditions and by increasing, in conjunction with the associated equipment, the number of trunk routes over which the Middlesbrough operators will dial direct to subscribers in distant towns. Furthermore, the number of routes



3 *Main features of an underground telephone-cable system*

over which operators in distant towns will dial direct to subscribers in the Middlesbrough automatic area will be increased, so reducing the number of calls the Middlesbrough operators will need to handle. The trunk routes over which operators dial now, and will dial when the new exchange is opened, are shown in Fig. 2.

The Repeater Station

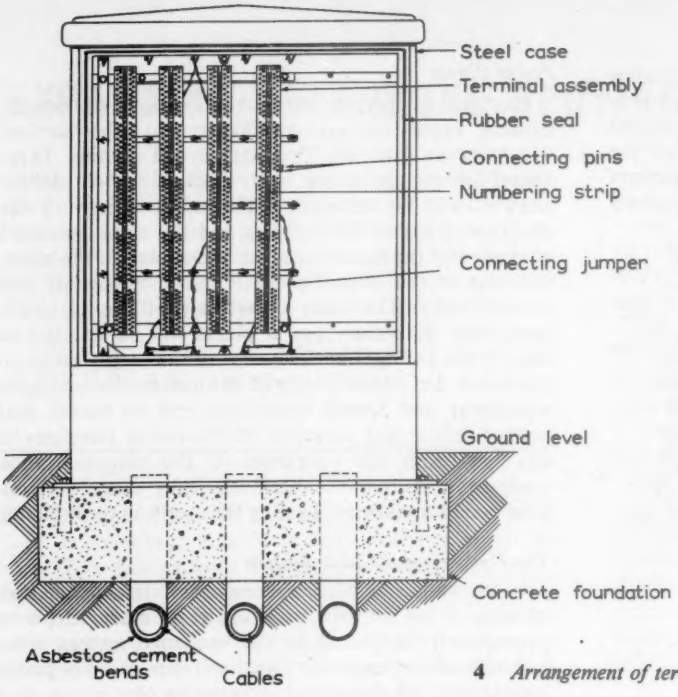
The repeater station will have amplifying equipment for trunks worked at audio frequencies, and terminal equipment for carrier routes linking Middlesbrough with Newcastle and Leeds. The route to Newcastle is already in service at the existing exchange, and it will be transferred to the new one. It can provide twenty-four channels of communication, each using a separate 4 kc/s band in the range 12–108 kc/s, on one pair of wires. Two separate cables specially laid for carrier working connect Middlesbrough with Newcastle. Each has twenty-four pairs of 40 lb/mile conductors and transmits speech in one direction only via two intermediate repeater stations spaced 12 miles apart. The Leeds–Middlesbrough carrier system is being constructed and will be brought into service with the new exchange. It will provide sixty communication channels on each pair of wires in specially made low-capacitance cables with 36 lb/mile conductors suitable for transmitting frequencies between 12 and 250 kc/s. Two cables, one for each direction of transmission, are being laid and equipped with repeater stations at 13-mile intervals between Leeds and Middlesbrough.

Power Plants

Electrical energy for the communication equipment, lighting, ventilating, air-conditioning and other services will be taken from the Electricity Board's mains. Three Diesel-driven generating sets, each able to deliver 133 kW, will be installed, sufficient to satisfy all the electrical needs of the building and the communication equipment if the mains supply is interrupted. If the mains fail, one of the Diesel sets will start immediately and automatically. The other Diesel sets will be manually controlled. Subsidiary power plants will be installed to convert the voltage and frequency of the supply mains to the lower d.c. values required to operate the telephone switchgear and speech amplifiers, and to ensure that neither failure nor variation of the mains interferes in any way with the operation of the communication equipment. Automatic thermostatically controlled oil-fired boilers are already heating the rooms in the building.

The Underground Cable System

In an underground telephone-cable system, one pair of wires is led into the exchange from every telephone permanently connected to the exchange, except when two subscribers share one line. Each wire of every pair is individually insulated and electrically continuous in a multi-wire cable from the exchange to a point as near the telephone as is practicable. Usually several months are needed to complete the laying of underground cables. Most of them are drawn into pipes, the laying of which necessitates excavating trenches in roads. When people ask for new telephones to be installed they usually want them to be working quite soon. The telephone administration is equally anxious to connect new lines quickly so as to fulfil its obligations to the public and to the Treasury. Therefore the administration's policy is to lay cables in anticipation of demands for services, that is to say soon enough to enable services to be given promptly when they are sought, yet not so soon as to have capital unprofitably invested in the form of idle plant. Hence telephone-cable systems are constructed to satisfy forecasts of how many, when, and where, telephones will be required in future years. The forecasts foretell as accurately as possible the growth likely at five-year intervals up to twenty years. Actual growth is rarely the same as that forecast, and telephone-cable systems are thus made flexible so that pairs of wires in the larger cables nearer the exchange can be switched to wires in several different smaller cables, which connect with premises where telephones are needed. The most modern flexibility devices, called *cabinets* and *pillars*, have been installed on the Middlesbrough system. They are weatherproof air-tight containers erected above ground level in unobtrusive accessible places on footpaths. They contain assemblies of terminals, and they are fitted at the junctions of the various stages of the cabling system. Every wire in every cable is connected to a separate terminal. The terminals are arranged in pairs vertically on each side of an assembly. Pairs of wires from the exchange are connected to one side, and pairs to tele-



4 *Arrangement of terminal assemblies in a cabinet*

phones are connected to the other. Exchange pairs are joined to telephone pairs by means of jumper wires which can easily be fitted or altered to satisfy changing needs without cutting into cables. As many as 800 pairs can be connected through a cabinet and up to 100 pairs through a pillar. The cabling system is shown in Fig. 3, and the details of a cabinet are shown in Fig. 4. The cabling system is being constructed to satisfy all probable future demands promptly. In addition, it will enable all the new services required before the new exchange is opened to be provided by the existing exchange, in such a way that cable surplus to ultimate needs is not provided, and all services operating at the time of the change-over can be transferred from the old exchange to the new within three to four minutes.

The New Electric Power Collection at the Science Museum

THE opening of the new Electric Power Gallery at the Science Museum, South Kensington, by Lord Hailsham, Minister of Education, on the 20th May, was the culmination of several years' close co-operation between the Science Museum and the electrical industry, working through the Electrical Exhibitions Committee of The Institution. The new Collection covers an area of 12 000 square feet, and the cost—about £75 000—has been borne in approximately equal shares by H.M. Government, through services performed by the Ministry of Works in the building, decorating and furnishing of the gallery; by the electricity supply industry, mainly through the C.E.A. and Area Boards; and by the electrical manufacturers, mainly through the British Electrical and Allied Manufacturers' Association and the Cable Makers' Association.

Opening Ceremony

In the absence of the President, who was unfortunately indisposed, Dr. Percy Dunsheath (Past-President, Chairman of the Electrical Exhibitions Committee) speaking on behalf of the contributors, asked Lord Hailsham, who, as Minister of Education, is responsible for the Science Museum, to accept the new Collection and formally to declare the Gallery open.

The Director of the Science Museum, Mr. T. C. S. Morrison-Scott, then invited the Minister to speak and referred to an incident of a different character which had occurred when they were at school together. On that occasion Lord Hailsham had conducted Mr. Morrison-Scott for a birching. Lord Hailsham, who said his recollection of the earlier incident was no less keen that that of the Director, but probably more pleasant, in

The south-west corner of the Electric Power Gallery

On the screen separating the main gallery from the nuclear energy compartment is a design by Reinganum made of aluminium, with colour effects produced by anodizing, symbolic of the peaceful use of atomic energy.

a brief and witty speech thanked the donors, congratulated those responsible for mounting the exhibition, and accepted the Collection. As the formal gesture of opening, he pressed the control button of a million-volt impulse generator, and the opening ceremony literally went with a bang.

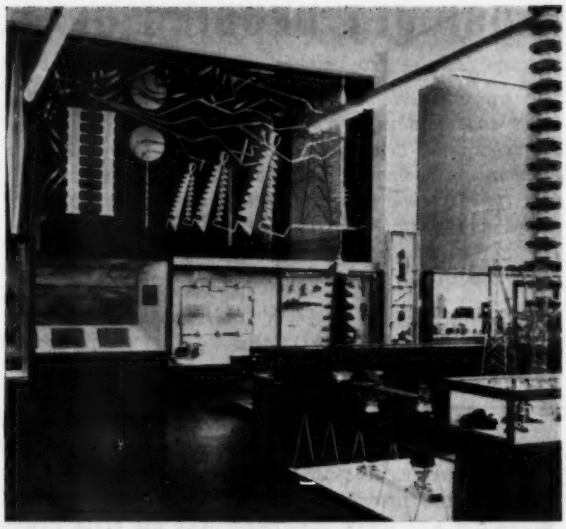
The Gallery

The visitor reaches the new gallery after passing through the collection dealing with the primary sources of energy and their application to man's use. The Electric Power Collection comes as a natural continuation of this, since it shows the conversion of the energy from these sources into a form in which it can be conveniently distributed for use wherever it is needed.

The Collection portrays the growth of the electric power industry to its present dominating stature, from its origin in the discoveries of the natural philosophers of the early 19th century and its gradual emergence as a result of the application of their discoveries by their practical-minded successors. This earlier development is illustrated by many important original pieces of apparatus and machines, selected from the wealth of historical material collected by the Museum over the years, supplemented by models and dioramas. For example, forming a fitting introduction, there is a working reproduction of Faraday's original apparatus of 1831, with which he demonstrated the continuous production of an electric current. Modern practice is dealt with in a logical sequence covering generation (this includes an exhibit on nuclear power), transformation, transmission, distribution and utilization. Here again the exhibits are mostly actual pieces of equipment, but models, dioramas and panel displays also form an essential part of the presentation. Many of the exhibits are working; outstanding among these is a million-volt impulse generator, as used, for example, in the testing of power-line insulators and cables.

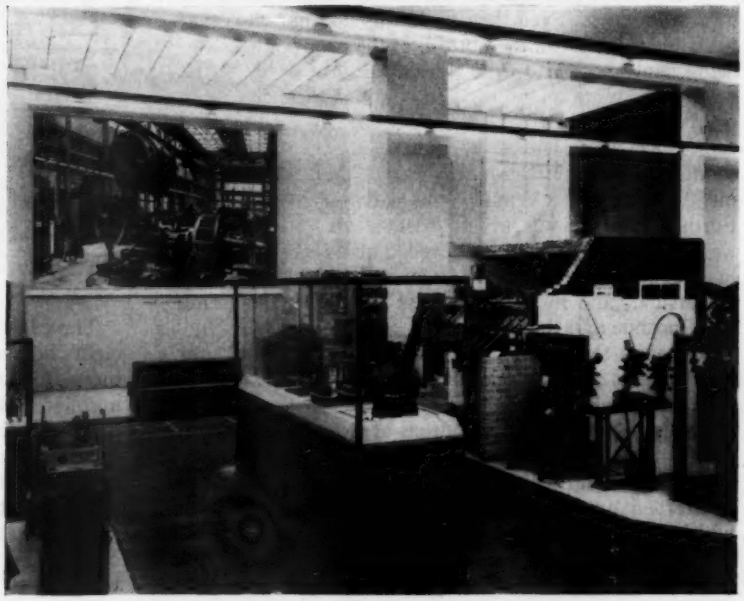
The gallery itself is spacious and light. Decorative features which contribute to its general atmosphere are two large metal screens, forming parts of partitions, in designs symbolising electric power and the peaceful uses of nuclear energy. Another striking feature is a very large painting of the interior of a heavy electrical manufacturing shop, so hung that the visitor has the impression that he is looking into an actual factory.

The presentation of the Collection is such as to appeal to the general visitor as well as to the more knowledgeable, who may wish to extend a general acquaintance with the subject or even to follow up a particular aspect in some detail.



The north-west corner

The design panel, also by Reinganum, representing electric power, forms a screen separating the impulse-generator section from the main gallery. The flashes from the generator may be viewed through the panel. In the right foreground is the transmission exhibit.



General view showing switchgear

On the wall is the painting by Terence Cuneo of a heavy electrical manufacturing shop.

FLUSH-JET BEDDING OF RIVER CABLES

The transmission of electricity across rivers, harbours, lakes and marshes, often in the presence of submerged obstacles and dense river traffic has long presented problems to the electrical engineer. This article describes a new, rapid method pioneered in Germany for the laying of cables and flexible plastic pipelines in such conditions. The author is with Alnwick Harmstorf Bergungsreederei, Hamburg-Altona.

POSTRAT SCHRÖDER

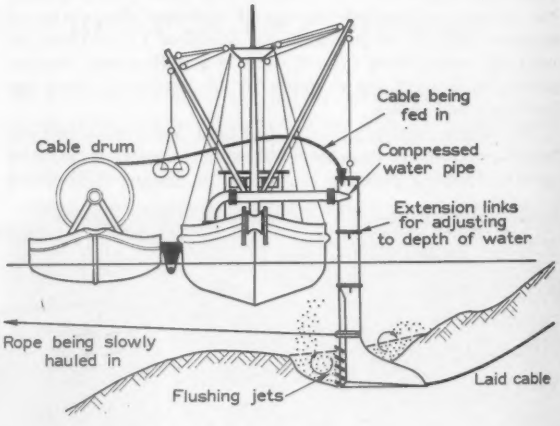
LAYING river cables and pipelines across stretches of water and providing islands with electricity, fresh water and telephone connections are tasks which provide engineers with an ever-increasing number of new problems. Only seldom can bridges be utilized for such purposes, and even then, swivelling or opening bridges are unsuitable. If cables and pipelines are simply laid out on the river bed or sea bottom without provision being made for ample covering, they are subject to the danger of damage by ships' anchors and ice-drift.

It thus proved necessary even in the early days of cable laying to find ways and means of ensuring the safe embedding of cables and water pipelines. There was then no alternative but to dredge deep grooves, into which the cables were laid and which were later filled in again. This method often proved rather difficult, particularly when strong currents quickly refilled the freshly-dredged grooves, and necessitated the costly employment of several dredgers. Even then there was no guarantee that the cable was laid on the bottom of the groove instead of being bent and laid on the side of the groove. With the flush-jet bedding method, all these difficulties have been overcome and in the past few years nearly 200 miles of cable have been laid in this manner. The utility and economy of the method has become well known, not only throughout Germany but also in neighbouring European countries. Only in recent years various cables were laid by this method in Sweden across the Göta Elf, in Denmark across the Limfjord at Oddesund and Aggersund, and in France across the Seine, the Loire, the Garonne and the Dordogne.

Although this method was used in the past only for cable laying, it has already been successfully employed with polyethylene conduit pipes.

Like most worth-while solutions to technical problems, the method, illustrated in Fig. 1, is essentially simple. By means of a high-pressure jet of water, the river or sea bed is churned up, creating a temporary narrow ditch into which the flexible pipeline or cable is laid in the same operation. Owing to the very small width of the ditch (8 inches at the most), it fills up immediately in the course of the operation, covering the cable with a thick protective layer of bed soil corresponding to the depth at which the cable is laid.

The injector, which is sunk deep into the sea or river bed from the cable vessel, is the most important single piece of equipment. It is of strong rectangular steel construction with various channels for the flushing water and a slide channel for the cable to be laid. Drilling and flushing jets are adjusted in various positions at the end of each flushing water channel. Water, generally under a pressure of 12 atmospheres, is pumped into the channels from a pumping set on the cable-laying vessel, forcing strong jets of water through the nozzles, breaking up and dispersing the surrounding bed soil. Immediately above the surface of the river bed, a hauling rope is fixed to the injector and is run through a block at the marker point on the bank and back to the windlass on the cable layer. When this rope is hauled in by the windlass, the injector and the cable-laying vessel (lying broadside on to the rope) are drawn to the marker point, as shown in Fig. 2. The jets of compressed water from the end of the injector imbedded in the bed soil thus flush a narrow ditch along which the injector is drawn.



1 *Schematic of the flush-jet system*

The cables or pipelines are usually coiled in rings or eights or wound on drums carried in an auxiliary vessel moored alongside the cable vessel. The cables are fed over a roller system to the cable vessel and into the cable channel in the injector, being fed out at the bottom of the injector in accordance with the permissible bending radius, thus forcing themselves into a straight line at the bottom of the flushed ditch at the determined depth. The roller system and the bottom of the injector are so constructed that pipelines are not subjected to any buckling or kinking.

The cable vessel carrying the pumping sets and winches and also the auxiliary vessel carrying the cable drums are both of small size, with a draught of only 4 ft, and are able to operate close to the shore, in harbours or in shallow coastal waters. The flush-jet method can also be employed in swamps unsuitable for navigation, on flats or sandbanks, on shallow rivers (by the use of small transportable pontoons) or from the shore itself. The cable-laying vessel with its auxiliary, both lying in the direction of the current, present no hindrance to shipping when laying cables or pipelines, which is a decisive factor on important waterways.

A further advantage of the flush-jet system is its speed. With fairly favourable river-bed conditions, cables or pipelines can be laid in one or two days, according to the breadth of the river, whereas the preparation and maintenance of a sufficiently deep dredged groove would take weeks. This factor alone is proof of the economy of the flush-jet method as opposed to the dredger system. Furthermore, if a cable laid by the new method falls into disuse, its condition is usually good enough to enable it to be lifted and used on other routes.

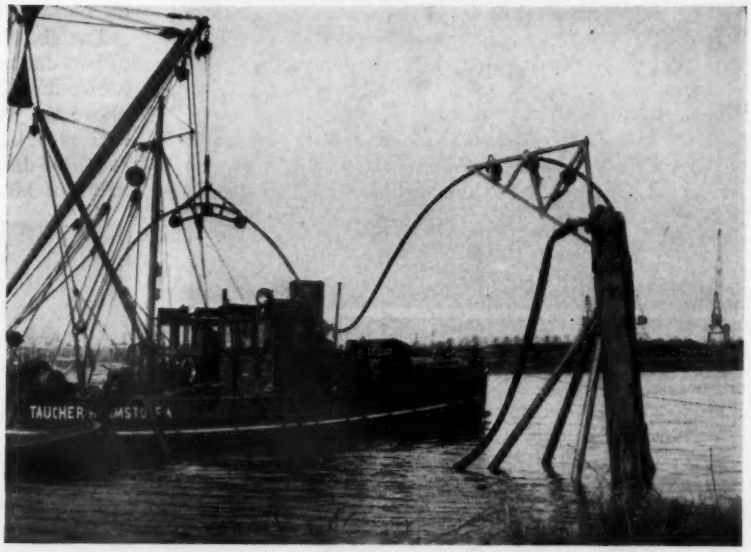
The factor of the depth of water—one which often poses a problem for dredgers—has no decisive influence on this new method of imbedding cables. As the water depth increases, extension links can be fitted to the injector gear and detached in shallower waters. This can also be applied to tidal waters. The suitable depth at which the cable is to be imbedded depends upon the prevailing geological formation of the river or sea bed. Generally a depth of 10 ft below the bed is sufficient, but in certain circumstances cables can be imbedded to a depth of up to 16 ft. Even with very hard clay or with coarse pebbles and occasional stones a depth of up to 6 ft can be attained.

Before each cable is imbedded, the ditch is tested by a trial operation for silted-up obstructions such as parts of wrecks, anchors, chains, tree trunks, etc., in order to avoid damage to the cable or pipeline. The cable layers are equipped with lifting gear for clearing away any such obstructions after they have been located by one of the divers belonging to the ship's crew.

During recent years, the system has been continually improved and perfected in the light of experience, and it has kept pace with the progress of industrial and engineering development.

A recent introduction has been the bedding-in of flexible plastic tubing into which the cable is afterwards drawn. This has the great advantage that the cables in the tubing are in a completely dry condition and may, if necessary, be interchanged at any time. This method has all the advantages of considerably more expensive steel conduit without any danger of corrosion. During the past year, plastic tubes of diameters up to 125 mm were laid for the first time, and 60 kV oil-filled high-electric-strength cables were afterwards drawn into the tubes. An additional point of interest is that these cables were without the usual armour. At a river crossing point, six plastic tubes were imbedded in this manner for a city's superimposed 60 kV cable system. The tubes were imbedded at lateral intervals of only 2 m and the cables afterwards drawn in.

All these operations having been successfully concluded, it has now been shown that with this laying system, put into practice for the first time last year, a new way of laying high-electric-strength cables across rivers has been found. This method not only has great economical advantages but is also well suited to the often complicated construction of such cables.



2 *The injector sledge operating along the shore*

A REVIEW *of the Proceedings, Parts A and B*

SHORT REVIEWS OF PAPERS

On the following pages are some brief review articles based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the subjects, and the content of the articles is not necessarily confined to the subject-matter of the original papers.

Deep Electrolytic Tank

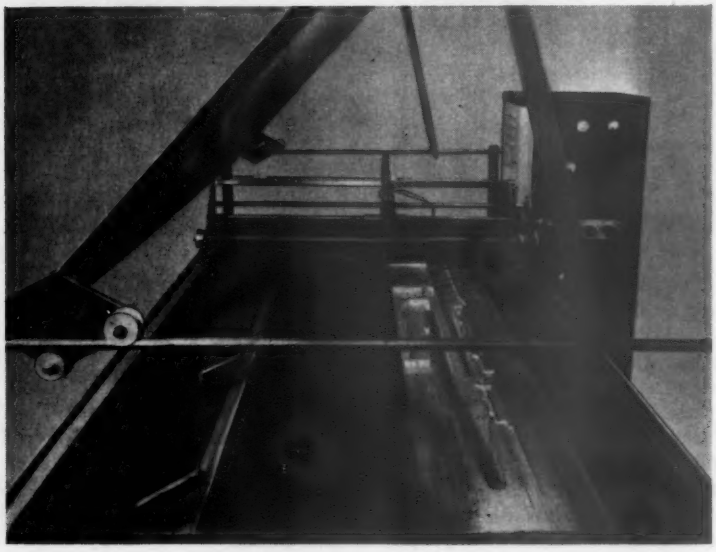
A short review of a Measurement and Control Section paper (No. 2179) entitled 'A Deep Electrolytic Tank for the Solution of 2- and 3-Dimensional Field Problems in Engineering', by E. R. Hartill, B.Sc.(Eng.), Associate Member, J. G. McQueen and P. N. Robson, B.A. The paper was published individually in October 1956, and it will be republished in Part A of the Proceedings. The authors are with the Metropolitan-Vickers Electrical Co.

THE ELECTROLYTIC TANK IS PLAYING AN INCREASING PART in electrical engineering design departments. The authors describe the design, construction and operation of a deep tank for solving both two- and three-dimensional field problems. They also give details of the precision electronic potential and potential gradient measuring equipment, together with an assessment of the accuracy achieved and the precautions required. The use of the tank is illustrated by a few typical applications which have been studied by the computation group in a large electrical engineering organization.

Fig. 1 shows a typical arrangement of the tank for a two-dimensional electrostatic field problem, which has rotational symmetry with different permittivities. The tank is 6 ft long and 4 ft wide and is made from impregnated wood. The four-times-full-size model represents the plug-and-spout bushing assembly for a certain type of switchgear, and it is shown in position below the armour-plate-glass plotting table. Equipotential lines, at various percentage intervals of the potential applied to the electrodes, are then plotted by using the precision electronic measuring equipment shown on the right of the photograph.

The above technique for the analogous representation of two-dimensional dielectric problems, and the use of a horizontal transparent plotting table mounted directly above the model have been described elsewhere.* The present design of electrolytic tank, however, also caters for three-dimensional problems, since it has an effective depth of 3 ft and holds a volume of electrolyte weighing 2 tons when full.

1 *The tank used for solving a two-dimensional field problem*



The paper describes the application of the tank to the three-dimensional study of the electrostatic field distribution near a string of suspension insulators on a transmission-line tower, together with an investigation of the effect of high-permittivity insulator units at the line end.

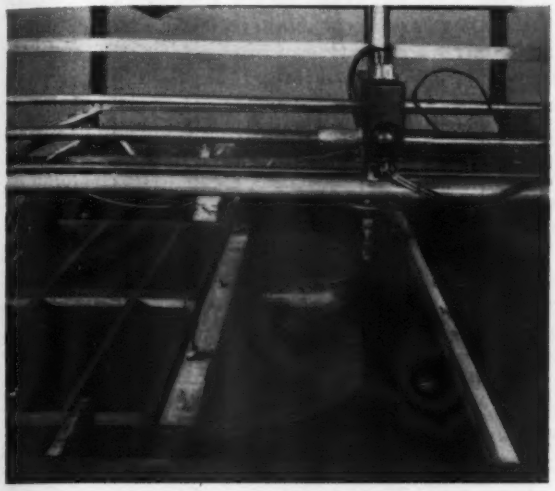
Fig. 1 shows how the plotting table can be swung and locked in a vertical position, either to gain access to the model beneath, or to form a vertical plotting table during three-dimensional studies, when equipotential plots are required in a series of vertical planes.

For such purposes the probe consists of a 2–3 ft length of glass capillary tubing, which carries an internal screened cable and which terminates in a glass-to-metal seal, with a 2 mm length of tungsten wire protruding from the glass probe. The probe is moved vertically by means of a rack-and-pinion mechanism operated by a

* DIGGLE, H., and HARTILL, E. R.: 'Some Applications of the Electrolytic Tank to Engineering Design Problems', *Proceedings I.E.E.*, Paper No. 1627 M, February 1954 (101, Part II, p. 349).

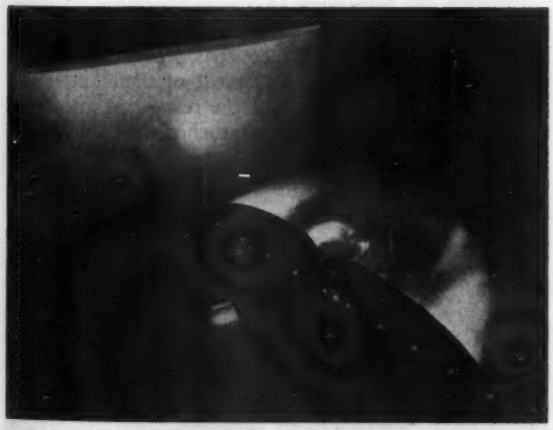
handwheel on the carriage, and the depth of the probe is indicated on the vertical plotting table by means of an illuminated cross-wire. Means are also provided for plots to be made in depth on any horizontal plane.

The deep tank has been used for the determination



2 *The tank used with a three-dimensional model*

of the accelerating and focusing potential gradients in a 50 MeV proton linear accelerator. These gradients, with other information, were eventually fed into a separate analogue computer to yield the required proton trajectories along the accelerator.



3 *Silver-plated electrodes for the model shown in Fig. 2*

The three-dimensional model (Fig. 2), which is four times full size, has a horizontal plane of symmetry about the centre line so that gradient measurements can be made in the surface of the electrolyte using a liquid double probe, and with the plotting table in the horizontal position. The paper gives the method of fabricating the large silver-plated electrodes shown in Fig. 3, which are required for the model.

The liquid double probe (Fig. 4), used for gradient measurements, is made from Perspex, and is similar to that used by Sander and Yates,* except that some control of the meniscus at the probe tips is achieved by the use of silicone varnish. The two 1 mm bore probes are immersed in the electrolyte to a depth of about 2 mm, and electrical connection is made to the electrolyte in the bore by means

4 *Liquid double probe*

of two spirals of platinum wire. These spirals are accommodated in a larger-bore tube in the main body of the Perspex. In this way metal-to-electrolyte polarization is effectively removed from the surface of the electrolyte. This is necessary because the presence of a polarization potential in the electrolyte surface would upset gradient measurements in the surface.

The voltage pulse between the two probes spaced 5 mm apart, gives the gradient, and is measured by means of a comparator, with special feedback amplifiers in the electronic equipment. This equipment also contains two pulse generators for supplying each of the model electrodes. The generators are arranged so that one of the probes is always at earth potential; this eases the amplification and measurement of the voltage between the probes. The output from the double probe is fed directly

* Sander, K. F., and Yates, J. G.: 'The Accurate Mapping of Electric Fields in an Electrolytic Tank', *Proceedings I.E.E.*, Paper No. 1370 M, August 1952 (100, Part II, p. 167).

to an input circuit, the valves and components of which are mounted in the small box shown on the carriage in Fig. 2. The switch enables gradient measurements to be made relative to either probe, or potential measurements to be made relative to one probe.

Further examples of the application of the deep electrolytic tank to typical engineering problems are given in the paper. 621.317.729.1

Thermal Storage Heaters

A short review of a Utilization Section paper (No. 2284) entitled 'Development of Transportable Thermal-Storage Space Heaters', by E. Bates. The paper was published individually in February 1957, and it will be republished in Part A of the Proceedings. The author is with the Eastern Electricity Board.

THE COMBINATION OF A NUMBER OF CONDITIONS HAS DRAWN attention, over the past few years, to the urgent need to improve the load factor of demand on electricity supply systems, including transmission lines and distribution networks as well as power stations.

A progressive shortening of working hours, their compression into a five-day week, and a widespread reluctance to accept shift working or any other form of staggering hours, contribute seriously to the relatively low load factors being experienced, and narrow considerably the field to be explored in search of ways of improving the position.

Direct forms of electric space heating have been criticized for the addition they make to demands for power, especially since this component is not only of short duration but occurs at times when other components of demand are bound to be high.

Certainly the demand increases as the temperature falls. Fig. 1 shows the simultaneous maximum demand on the Eastern Electricity Board's system on:

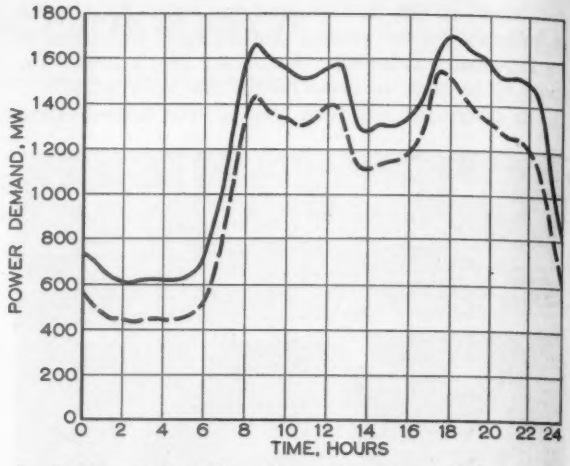
(*a*) Tuesday the 7th February 1956, when the extremes of temperature were 33·5° F and 40·5° F.

(*b*) Tuesday the 21st February 1956, when the extremes of temperature were 20·5° F and 30° F.

Since the same days of the week have been chosen and they are only a few days apart, the daylight conditions are substantially the same, and it is reasonable to assume that the difference in demand is accounted for by the difference in temperature. This may not be wholly due to space heating, however, for there may be increased cooking due to the need for more hot meals.

It was decided to concentrate on space heating as a specially suitable means by which load factors might be improved, because here was a chance not only to reduce day-time demand but actually to transfer it to night time.

This indicated the use of thermal storage in a form suitable for use in existing buildings of normal design and



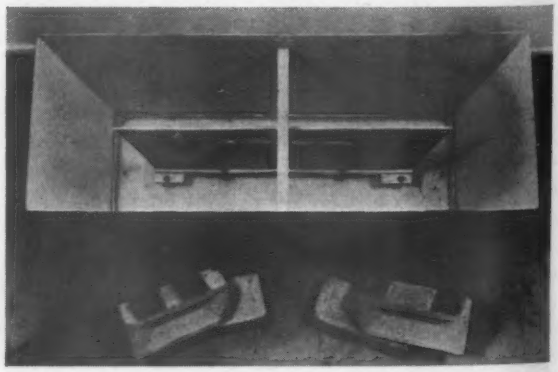
1 *Maximum demand on the supply system of the Eastern Electricity Board*

The broken curve was compiled on the 7th February 1956, when the mean temperature was 37° F. The continuous curve was compiled on the 21st February, when the mean temperature was 25·2° F.

construction. There had been earlier attempts in this country to develop the use of small transportable thermal-storage heaters, but with almost no result. This was probably because the relative charges for electricity and other fuels were unfavourable to the former. Also, insufficient attention was given to automatic means of control, and in any case the attempt occurred before electricity had reached the stage of acceptability that it now enjoys.

Progress had been made in certain European countries, and specimens of the heaters in use there were examined. By English standards their construction would be considered somewhat crude, and most of them required a measure of manual control of the release of heat. Consideration of these models strengthened the conviction of the author that his aim should be towards fully automatic control, and that this would be better applied to the

2 *Thermal-storage space heater*

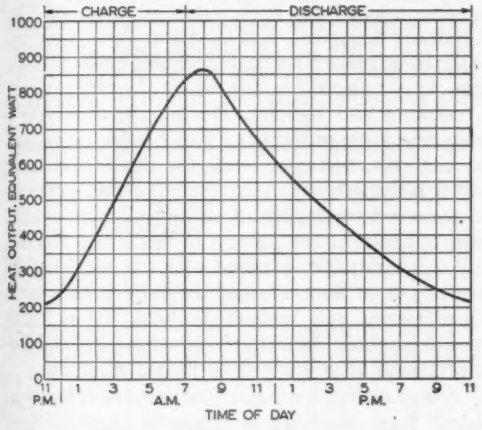


energy input, allowing heat discharge to occur at the natural rate.

After several exploratory prototypes had been produced and tested it was felt that sufficient progress had been made to warrant a larger experiment. The model used was in the form of a simple metal box containing an Inconel-sheathed mineral-insulated resistor embedded in an aluminium plate as shown in Fig. 2. The space between the element and the box was loaded with Fletton bricks, and the interstices were filled with sand. Several installations were carried out, the largest employing some eighty heaters, each loaded at 1 kW.

Although methods of automatic control were not at that time developed to the degree reached later, the installation was particularly satisfactory, and further progress was encouraged.

This was the stage at which English manufacturers became interested, and new designs having more sales appeal were introduced, though there was little fundamental change. Over the next few years, other firms produced designs, and the manufacture, sale and installation of heaters went ahead fairly rapidly. The thermal characteristics of the various models were substantially the same, and Fig. 3 is typical.



3 *Output characteristic of a typical 1·5 kW heater when in regular service*

Concurrent with development of the heaters was progress on methods of automatic control, which were largely based on the principle of using the outdoor conditions at night to forecast the heat requirements during the following day.

The earlier installations were carefully designed with proper regard to the thermal properties of the buildings concerned, but later, as was inevitable with progress that was becoming rapid, installations were sometimes carried out in buildings of unsuitable construction and sometimes with more regard for competitive first cost than for technical correctness.

Similarly, because of the competitive aspect, there was a tendency for manufacturers to increase the electrical loading of heaters without comparable adjustment of surface area and mass of storage material. This led to surface temperatures higher than those envisaged by the author, and introduced fire hazards when heaters were accidentally covered in such a way that free dissipation of heat was prevented—so causing temperatures capable of starting combustion. These, however, may be regarded as the normal teething difficulties of development, and they are capable of being overcome.

The author believes that this form of electrical space heating has a promising future; it will not only provide users with comfortable space heating at economic initial and operating costs but will also make a worth-while contribution to the improvement of the load factor of electricity supply. 621.365

Electrical Floor Warming

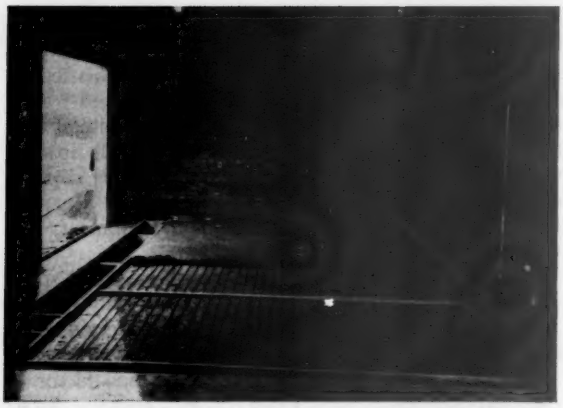
A short review of a Utilization Section paper (No. 2330) with the above title, by J. W. Moule, B.Sc.(Eng.), Member, and W. M. Stevenson, T.D., Associate. The paper was published individually in February 1957, and it will be republished in Part A of the Proceedings. The authors are with the South of Scotland Electricity Board.

IT IS NOTABLE THAT ONE OF THE MOST OUTSTANDING developments of our time—the nuclear generating station—is, indirectly, bringing about the widespread adoption of an ancient method of space heating. Improvement in system load factor has become of even greater importance than before, and Area Boards must now begin to build up the off-peak load required to provide optimum loading for the nuclear stations. Off-peak storage space heating is the most promising method of effecting a material improvement in load factor, especially during the winter months.

The Romans went to considerable trouble and expense in building air ducts under floors to enable hot air to be circulated which would heat the building by warmth radiated from the floors. The modern application of this type of heating began about 1911, when hot water, circulated in embedded pipes, began to be used for building heating. This method of space heating has not been widely adopted, no doubt owing to its greater cost and complications compared with the more conventional systems of space heating.

About twenty years ago, electrical heating cables were substituted for the hot-water pipes, and the first electrical floor-warming installations were carrried out. This method of heating was used to some extent in air-raid shelters during the last war, but it was not until about ten years ago that extensive development took place. It is now being successfully used in all types of building.

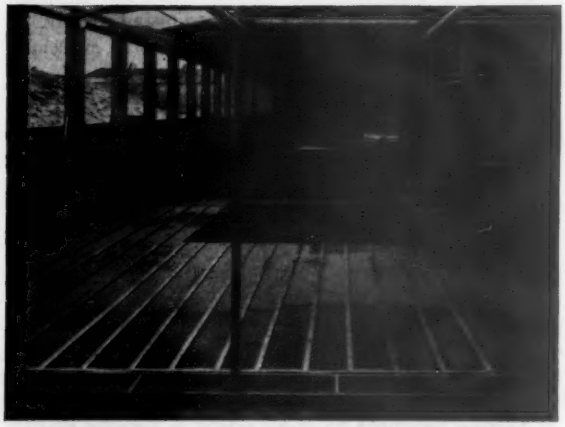
Electrical floor warming is one of the simplest methods of space heating. It is generally installed in concrete floors, advantage being taken of the thermal-storage



1 *Typical solidly embedded floor-warming installation*

properties of concrete to enable the electricity supply to be off-peak in character. Sufficient heat is stored in the floor to permit the maintenance of full warmth while the electricity supply is not available. The consumer can therefore purchase his electricity at the reduced off-peak tariffs now available in almost all areas in the country.

The heating cables can be either laid solidly in the concrete between the structural floor and the screed or drawn into a system of piping embedded in the floor. The former method is cheaper but suffers from the disadvantage that the cables cannot be readily repaired should a fault develop. Fig. 1 is an example of a solidly laid floor-warming installation. It shows the electrical heating cables laid out on the main floor of the building with part of the concrete screed in position. In practice it is found that the best results are obtained if the screed is about 2 inches thick.



2 *Withdrawable type of electrical floor-warming installation*

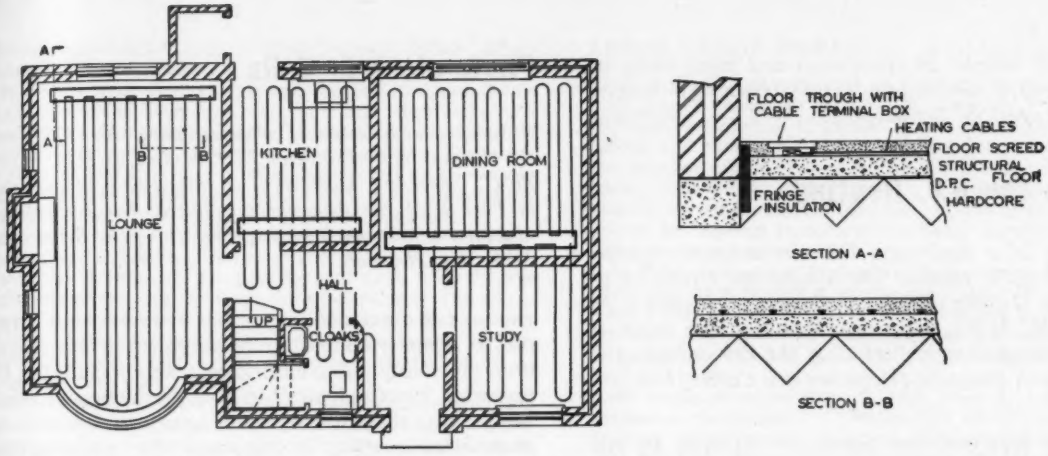
Fig. 2 illustrates the withdrawable type of floor heating. It consists of D-shaped metal housings placed in parallel lines across the structural floor of the building, the flat sides of the housings being uppermost. The housings are generally between 6 and 12 inches apart, the precise distance being determined by the electrical loading. They terminate in troughs at the two opposite ends of the room, and the depth of the troughs is such that, when the trough covers are in position, they will be flush with the floor surface. In small buildings, such as dwelling houses, only one trough may be necessary, the remote ends of adjacent housings being connected by a semicircular bend of steel conduit. The trough serves to give permanent access to the housings to permit the heating cables to be installed and to carry the electrical wiring and connections to the heating cables. Expanded metal is laid across the housings and secured to the flat side. Finally, a concrete screed about 2 inches deep is laid to give the top floor surface.

Fig. 3 is a plan of the withdrawable type of electrical floor warming used in a private dwelling house. A cross-section through the floor is given, and it will be noted that thermal insulation has been provided around the edge of the floor to minimize loss of heat.

The table sets out particulars of some electrical floor-warming installations in the south of Scotland. Most of the buildings have been in use for at least one year, and the heating arrangements are providing full satisfaction both in comfort and cost. Special mention may be made of the last building in the table, which is an eight-storey block of flats erected by Kirkcaldy Corporation. The flats are without fireplaces, and electrical floor warming provides the basic space heating, the tenants being entirely dependent upon electricity for space heating, water heating, cooking and lighting. During the first year's occupation, the average inclusive cost of electricity was 14s. 3½d. and 10s. 9½d. per week for three- and two-apartment flats respectively. Apart from the low operating cost, the tenants have expressed entire satisfaction with the system of heating. The success of these flats has led Kirkcaldy Corporation to proceed with the construction of further blocks of floor-warmed dwelling houses both of the multistorey and maisonette type. Many local authorities throughout the country now have in hand the erection of similar electrically floor-heated dwellings.

In the matter of first cost, even the withdrawable type of electrical floor warming is generally cheaper than alternative heating systems. Where a solidly-embedded heating cable is acceptable, the initial cost is much less than any alternative.

Since electrical floor warming gives more or less continuous heating, it is eminently suitable for buildings that are used for long periods of the day. It is obviously unsuitable for heating a hall which requires only one or two hours' warmth occasionally. Apart from exceptions coming within the last-mentioned category, it has been found that in annual operating cost electrical floor warming can generally compete favourably with other methods of space heating. Surprisingly large numbers of people compare the estimated cost of electricity with the estimated cost of coal, gas or oil, leaving other heating costs, such as boiler operating and maintenance costs, out of account. One main advantage of electrical floor warming, as indeed of all forms of electrical heating, is



3 *Layout for an electrical floor-warming system in a private dwelling*

that, having met the cost of electricity, no other appreciable expenditure on heating is incurred.

Electrical floor warming also has advantages which cannot be expressed in a monetary way. From a comfort point of view, the 'warm feet and cool head' effect makes floor warming the ideal method of space heating. Moreover, since it is essentially a radiant method of heating, air movement is minimized. This, together with the low operating temperature of the floor, enables internal decorations to be maintained in a fresh condition for a considerable period. A further important point is that the heating system is completely out of sight, leaving the floor and wall space unobstructed in any way. The use of electricity does not entail the combustion of fuel on the premises, and there is therefore no emission of any kind to contaminate the air or harm the building exterior. No fuel or products of combustion have to be handled, and this not only eliminates noise and dust but saves the considerable trouble sometimes involved in obtaining fuel when it is most needed during difficult wintry conditions. It can be confidently asserted that electrical floor warming is the cleanest of all space-heating systems. 621.365

Particulars of Some of the Larger Electrical Floor-Warming Installations in the South of Scotland

Type of building	Size of building		Building heat loss	Heating installation		Estimated annual consumption	Average temperature rise	Capital cost of floor-warming installation	Estimated annual operating cost
	Floor area	Volume		Loading in floors	Loading in walls and ceilings				
	ft²	ft³	B.t.u./h	kW	kW	kWh	°F	£	£
Industrial	24 000	365 000	975 060	284·07	2·25	406 000	32	5 170	1 070
School	42 200	496 425	1 300 000	389·77		650 000	30	11 550	2 750
Public services	30 500	258 000	870 000	232	30	393 000	35	9 645	1 500
Fire station	6 276	61 500	238 000	68·25	0·75	110 000	32	1 910	458
Industrial	8 880	71 040	266 400	110	—	127 000	32	1 207	370
Domestic	10 630*	79 740*	510 000	148	—	250 000	32	3 950	780

* Living room and hall only.

SYNOPSES OF PAPERS

Circular H_{01} Waves in Guide Bends

A synopsis of a Radio and Telecommunication Section paper (No. 2369) entitled 'Propagation of the Circular H_{01} Low-Loss Wave Mode around Bends in Tubular Metal Waveguide', by Professor H. E. M. Barlow, Ph.D., B.Sc.(Eng.), Member. The paper is published this month in Part B of the Proceedings. The author is Pender Professor of Electrical Engineering, University College, London.

ALTHOUGH THERE IS AMPLE EVIDENCE OF THE SUITABILITY of a straight length of hollow metal tube as a waveguide supporting the circular H_{01}-mode for long-distance communications, bends in the guide still present a serious problem. An examination of the conditions required to maintain as nearly as possible the appropriate field distribution at a bend leads to the important conclusion that the wavefront, represented by an equi-phase plane, must remain radial with respect to the centre of curvature. The evidence shows that there are two ways of approaching this requirement: (*a*) by varying the permittivity of the dielectric medium inside the guide over its cross-section and (*b*) by varying the surface reactance of the guide around its circumference. The first of these

proposals is simpler in application and more likely to meet the need, if suitable cellular polystyrene or polythene can be obtained for the purpose. 621.372.823.2

Triodes for R.F. Heating

A synopsis of a Radio and Telecommunication Section paper (No. 2379) entitled 'The Design and Operation of High-Power Triodes for Radio-Frequency Heating', by W. J. Pohl, M.Sc., Associate Member. The paper is published this month in Part B of the Proceedings. The author is with Standard Telephones and Cables, Ltd.

THE PAPER SETS OUT THE IMPORTANT FACTORS IN THE design of high-power triodes for use in radio-frequency heating equipment. The relations between Class C oscillator performance and valve characteristics lead to relatively simple design principles. These, in combination with modern methods of construction, have made it possible to achieve an unusually high conversion efficiency with relatively low dissipation on the grid, thus ensuring adequate grid safety under varying load conditions.

The design principles are embodied in a new range of industrial triodes which are briefly described. 621.385.3:621.365.5

Photo-electric Cells

A synopsis of a review of progress (paper No. 2388) with the above title, by Professor J. D. McGee, O.B.E., M.Sc., Ph.D., Associate Member. The review will be published in Part B of the Proceedings. The author is Professor of Instrument Technology, Imperial College of Science and Technology, London.

THIS IS THE FIRST PROGRESS REVIEW OF PHOTO-ELECTRIC cells as a separate subject to be published by The Institution. Previously photo-electric cells were included in the review of 'Electrophysics'. In his introduction Professor McGee says that an understanding of the physics of the photo-electric effect is necessary for understanding photo-electric cells and other devices that depend upon it. So in his progress review he first surveys briefly the experiments that led up to Einstein's theory, and then follows this by outlining the modern theory of the photo-electric effect. Next comes a description of the methods of making present-day photo-electric cathodes, their characteristics and those of a few of the electronic tubes in which they are incorporated. A brief account of solid-state theory introduces the internal photo-electric effect, and the review ends with descriptions of the photo-conductive and photovoltaic cells. 621.383

OBITUARY

FREDRIC LAFARGUE BEST

Fredric Lafargue Best, who died on the 6th December 1956, was born on the 29th August 1893. He received his early education at Brixton Secondary School, and practical training with the Langdon Davies Motor Co. He was one of the many young men whose technical training was interrupted or postponed by the First World War, when he served with the Royal Engineers, so that it was not until 1919 that he entered the Northampton Engineering College in Clerkenwell to begin training as an electrical engineer. Like most of his associates there, he appreciated that it was a belated start, but he was a serious student, intent on making the best use of his opportunities; that is not to say, however, that he did not take an active part in the less academic College activities, for he was always a good sportsman.

In 1924 he joined the Cambridge Instrument Co. as Chief Test Engineer, and in 1933 was appointed Works Manager with Electroflo Meters. Then he became a consultant. Thus he gathered experience in preparation for his real job in life, which was to found, at Felixstowe in 1936, the company Best Products Ltd., manufacturers of high-quality domestic appliances, relays and thermostats. Although styled 'Managing Director', he was also the company's Designer and Chief Engineer, and spent the rest of his life in building up its good reputation, even in the difficult years after 1939. He was very successful, and in 1946, when his Company became associated with Cossors Ltd., he retained his position as a very active Managing Director; he died in harness.

A man with very wide interests, he was active in the Ipswich and District Electrical Association, was at one time a member of the Ipswich Engineering Society, a member of the B.E.A.M.A. and of a number of its committees, and an active supporter of the East Anglian Publicity Club. He was sometime Chairman of the Felixstowe Music and Arts Society, and will be remembered for his interest in cultural activities. Mr. Best's outstanding characteristic was thoroughness in all his activities, as well as in his work. Even in his recreations in later life he always took pains to make himself proficient by tuition and practice; one remembers tennis, flying, fishing, shooting, gardening and, what was possibly his favourite sport, yachting. As an old Northampton student, he did much to popularize sailing amongst the present students of the College, being a beneficent supporter and Commodore of their yachting club. He was also a member of the Royal Harwich Yachting Club, owned and piloted his own aircraft, and actively supported two local flying clubs.

Mr. Best is survived by his widow, a son and a daughter.

He joined The Institution as an Associate Member in 1927 and was elected a Member in 1950. He was on the Inaugural Committee of the East Anglian Sub-Centre and served as Vice-Chairman of this Centre 1955–56, when he retired owing to ill health.

J. C. R.; R. A. W. C.

FREDERIC HORTON CLOUGH

Frederic Horton Clough, C.B.E., who died on the 25th February 1957, was born in Melbourne, Australia, on the 21st November 1878. He was educated at the Church of England Grammar School, Geelong, Australia, and his technical education was obtained at

Melbourne Technical College, Finsbury Technical College, King's College and Owens College.

In 1896 he commenced an apprenticeship with the Austral Otis Engineering Co. of Melbourne, working in their shops and on the erection of gold-mining machinery. Training was continued on removal to England in 1898 by an apprenticeship with Siemens Brothers of Woolwich—in workshop practice and design work in the drawing office. This was followed, in 1901, by experimental test work with Siemens and Halske of Charlottenburg, Berlin.

In June 1902 he joined the design department of British Thomson-Houston, and in 1906 became responsible for the design of turbo-alternators. He retained this position until 1919, when he was promoted to Assistant Chief Engineer of the company. This period was broken, however, in 1917–18, when he was lent to the Admiralty as Technical Adviser to the Director of Torpedo and Mining. The value of Mr. Clough's work there was acknowledged by his appointment as a C.B.E.

Mr. Clough was widely known, and his duties occasioned many visits abroad: to the United States, Canada, France, Germany and Belgium. He was a member of many committees, including those of the B.E.A.M.A., B.S.I., and E.R.A., and he had represented The Institution at meetings of C.I.G.R.É. In 1921–22 he was President of the Rugby Engineering Society.

His responsibilities were spread over an extensive field, but he was never too busy to try to help where it was needed, and his colleagues, even those engaged in highly specialized work, could always discuss their interests and difficulties with him. He held decided views on the need for sound technical training of engineers, and took an influential interest in the B.T.H. schemes of apprenticeship training. His personality made him an asset in any company and his characteristic, if somewhat subtle and whimsical, sense of humour will always be remembered by those who knew him.

October 1947 saw the beginning of his retirement, when he moved to the country near Chichester. He is survived by his widow and one daughter.

Mr. Clough joined The Institution as a Student in 1898 and was elected an Associate in 1902 and a Member in 1912. He served on the South Midland Centre Committee 1931–34 and 1936–37, and was Vice-Chairman of this Committee 1934–35 and Chairman 1935–36. He was also a Member of The Institution of Civil Engineers. He was the author of a paper entitled 'Stability of Large Power Systems', which was published in the *Journal* in 1927. H. T.

WILLIAM STUART GEARING

William Stuart Gearing, who died on the 5th January 1957, was born on the 29th March 1900. He was educated privately and at York Place, Brighton, and became a pupil of Crompton and Co., Chelmsford, in 1916; during his pupilage he attended evening classes at Chelmsford Technical School, and later at the Regent Street Polytechnic.

In 1920 he was appointed Assistant to the London Manager of Crompton and Co., remaining in that position until 1927. In that year the firm became Crompton Parkinson Ltd., and he was promoted to Technical Engineer. He left this employment in 1932 to become London Engineer with Watford Electrical and Manufacturing Co., and after three years he joined Johnson and Phillips as Senior Technical Engineer in their London office. In 1941 he was promoted to Deputy London Manager, and five years later to London Manager. He was enthusiastic about his job and had great faith in the importance of his work. His particular duties brought him into touch with engineers responsible for many large-scale industrial and other projects both at home and oversea, and he was well regarded by them for his engineering and administrative ability.

Mr. Gearing died after a long and painful illness which he bore with the utmost courage and fortitude. His hobbies included gardening and art, and he showed promise as an artist. He is survived by his widow and a son.

Mr. Gearing joined The Institution as an Associate in 1942 and was elected an Associate Member later that year and a Member in 1951. G. G. M.

LLOYD LESLIE HORRELL

Lloyd Leslie Horrell, who died on the 13th February 1956, was born near Peterborough on the 27th February 1878. He was educated at Holbeach Grammar School and Bedford Modern School, and received his practical training from 1894 to 1899 in the Peterborough workshops of the Great Northern Railway, during which time he studied part-time at Peterborough Technical College. He left the railway company in order to go to sea, and one of his seagoing experiences was being shipwrecked off the American coast near Delaware.

In 1900 he returned to England and held positions in municipal power stations at Bedford, Coventry and Walsall. He emigrated to South Africa in 1907 and for a short while was Engineer of the Hatherley lead mine near Pretoria. When the mine went into liquidation, he obtained employment at the Consolidated Main Reef gold mine.

His municipal career began in 1909, when he was appointed Assistant to the late Mr. T. C. Wolley Dod, who had been General Manager of the Pretoria Municipal Electricity Department since 1904. When Mr. Wolley Dod retired in 1928, Mr. Horrell succeeded him as General Manager and Chief Engineer.

The Pretoria electricity undertaking made great strides under his guidance. He took a special interest in the development of the domestic demand for electricity, and to this end inaugurated a hire-purchase scheme for consumers to buy appliances, and established showrooms for the display of domestic appliances and for the demonstration of cooking by electricity.

Mr. Horrell had boundless energy and was intent only on the efficient development and conduct of his undertaking. He had a great pride in his department and was satisfied only with a very high standard of work. Although a strict disciplinarian, he never demanded more of his subordinates than he was prepared to do himself. To anyone in grave trouble he was extremely generous and sympathetic, and on many occasions only the recipients had knowledge of his kindness.

After his retirement in 1938 he set up as a consulting engineer. During the Second World War he served in a technical capacity on various Boards associated with South Africa's war effort. At the conclusion of hostilities he resumed his practice and was doing consulting work to within a few months of his death.

Mr. Horrell was President of the South African Institute of Electrical Engineers in 1937, having been a member since 1915. In 1917 he assisted in founding the Association of Municipal Electricity Undertakings of Southern Africa and Rhodesia and was President of the Association from 1931 to 1933. He was President of the Pretoria Rotary Club in 1936–37.

Mr. Horrell joined The Institution as an Associate Member in 1912 and was elected a Member in 1938. D. J. H.

ANDREW BRUCE MUIRHEAD

Andrew Bruce Muirhead, who died in a Glasgow nursing home on the 17th February 1957 after a very short illness, was born in Carluke on the 17th February 1875. He received his general education under the School Board of Rutherglen, and his electrical engineering education by private tuition and a correspondence course with the City and Guilds of London Institute. Practical training was obtained at Belhaven Ironworks, Wishaw, from 1891 to 1896. For the next three years he was in the employ of R. Y. Pickering and Co. of Wishaw, as an electrician, and in June 1899 he joined D. Selby Bigge and Co., in a similar capacity. In 1901 he was promoted to District Manager in South Wales, where he was engaged on colliery electrification work until 1909, when he was appointed Manager and Technical Engineer at the Company's Glasgow office. From that time, until 1947, when the Coal Industry Nationalization Act came into force, he was actively engaged in the installation of power generating plant at collieries. He devoted much time to the problem of burning low-grade fuels in colliery boiler plant and was a member of the panel appointed by the Minister of Fuel and Power to study this subject after the war. He was responsible for many important power development schemes

including an extensive hydro-electric scheme in Spain, and also the reorganization of various steam and power plant installations.

Mr. Muirhead became a partner in the firm of D. Selby Bigge in 1920, and remained Managing Partner until his retirement from active business in 1954.

He took a keen interest in the affairs of the Association of Mining Electrical and Mechanical Engineers, of which he was President in 1922–23, and was a member of their Advisory Committee for forty years. He was also a member of the Mining Institute of Scotland, of which he was Vice-President at the time of his death.

In Lenzie, where he lived since 1910, he was active in church affairs, being Session Clerk of his own church, and also a member of the Glasgow Presbytery. He had been a widower since 1936.

Mr. Muirhead joined The Institution as an Associate Member in 1929 and was elected a Member in 1938. T. D.

ERNEST PETERS NEATE

Ernest Peters Neate, who died on the 23rd November 1956, was born on the 18th June 1878 at Portsmouth. Educated at Magdala House Academy, Portsmouth, he entered the Post Office as a telegraphist at the Central Telegraph Office in 1894. He continued in this capacity until 1900, when he was released for service with the Royal Engineers in the Boer War. During his employment in the Central Telegraph Office he studied part-time at the Telegraphist's School of Science and at the Northampton and Regent Street Polytechnics. He returned to England in 1902 and was appointed to the Post Office Engineering Department at Cambridge. Two years later he became Sub-Engineer and, in 1909, Second Class Engineer.

In 1915 Mr. Neate was again on active service, receiving a commission in the Royal Engineers (Signals). He returned to the Post Office in 1919. In 1928 he was promoted to Sectional Engineer, which post he held until his retirement in 1938.

Mr. Neate spent many years in the west of London and was actively concerned with the telephone and telegraph arrangements for the Empire Exhibitions at Wembley. Later he worked on the conversion of telephone exchanges to automatic working, beginning with the Sloane exchange, one of the first of the larger London exchanges to be converted.

He was a kindly man, and was fair in his judgments, particularly concerning staff. He had an enthusiasm for astronomy.

Mr. Neate leaves a widow, two sons and a daughter. The two sons are engaged in electrical engineering and are members of The Institution.

He joined The Institution as an Associate Member in 1913 and was elected a Member in 1922. H. B. S.

MONOGRAPHS AND PAPERS
published individually this month

Synopses of monographs and papers published individually before the next issue of the Journal are given below, and, unless otherwise stated, their dates of publication are this month. Reprints of all papers are available about two months after publication in the Proceedings. The prices shown below are post free. When ordering please quote serial number of paper or monograph. Books of 8 vouchers may be obtained from the Secretary, price 10s. each.

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MONOGRAPHS

A Spectrometer Method for Measuring the Electrical Constants of Lossy Materials *Monograph* 248 R

J. S. SEELEY, B.SC.(ENG.)

The analysis of the propagation of a plane wave at oblique incidence through a strip of lossy material is stated, the behaviour of the lossy material being completely represented by the use of a complex refractive index and a complex reflection coefficient. A measurement technique is described whereby these constants can be measured from a strip of material used in a 1 cm parallel-plate spectrometer. The analysis and measurement technique are checked by the application of the spectrometer method and the established waveguide method to the measurement of two ordinary lossy dielectrics. The spectrometer method may be used for the measurement of any homogeneous material, and is especially suitable for the examination of non-isotropic artificial dielectrics. The accuracy of the method is discussed for the measurement of the electrical constants of medium-loss materials with refractive indices between 0·5 and 2·0.

The Statistical Basis of Impulse Testing *Monograph* 249 M

T. J. LEWIS, M.SC., PH.D.

The normal procedure of impulse testing insulation involves the average of a series of similar tests and the determination of the percentage breakdown at a given impulse ratio. The basis of this procedure involves the properties of a series of Bernoulli trials, the outcome of each trial being either breakdown or non-breakdown of the insulation tested. These properties, which are of a statistical nature, are analysed, and the results expected for various types of insulation and impulse waveshape are given and compared with existing experimental data where possible. The probable outcome of a series of N impulse trials is shown to have a binomial distribution, and estimates of the errors involved are given. The effect of sample variation which applies particularly to tests on solid insulation is also treated.

The paper provides a statistical background against which the results of impulse voltage experiments may be judged.

The Thermal Properties of High-Voltage Insulants *Monograph* 250 M

P. H. G. ALLEN, B.SC.(ENG.)

Lack of agreement between published values of the thermal properties of high-voltage insulants necessitates the development of relatively simple methods for their measurement. Transient methods for the determination of the thermal diffusivity of solids and thermal conductivity of fluids are described with examples of their use and an estimate of their accuracy. Allowance is made for anisotropy in the case of solids. Suitable methods for determination of specific heat are discussed and the importance of the rate of change of density of liquids with temperature is stressed.

The Calculation of Cyclic Rating Factors and Emergency Loading for One or More Cables Laid Direct or in Ducts *Monograph* 251 S

H. GOLDENBERG, M.SC.

The knowledge of the loss load factor of a load cyclically applied to a cable laid direct in the ground or in a duct and the detail of the load current for the six hours prior to maximum core temperature are shown to be adequate for cyclic-rating-factor calculations. If the loss load factor is known without further calculation, the method is shorter than an earlier one described by the author. It is extended to deal with short-term emergency loads within accepted temperature limits and with groups of cables carrying diverse cyclic loads.

PAPERS

The Simulation of Distributed-Parameter Systems, with particular reference to Process Control Problems *Paper* 2376 M: *Part B*

J. F. MEREDITH, B.SC., *and* E. A. FREEMAN, B.SC.

In this paper simulator techniques for solving certain partial differential equations, generally occurring in process control engineering (e.g. heat exchangers) are investigated. Limitations associated with the method of dividing a distributed parameter system into a series of elements which may be represented by lumped-constant electrical networks are discussed and an alternative method of simulation is suggested which overcomes these limitations.

To illustrate the advantages of this alternative technique two practical distributed parameter systems are simulated. In the first, which is a heat exchanger, the technique suggested by the authors affords a great saving in apparatus for a given accuracy. The second example considered is a non-linear distributed parameter system for which previous methods of simulation are impracticable owing to the amount of apparatus involved.

Some Transistor Input Stages for High-Gain D.C. Amplifiers *Paper* 2382 M: *Part B*

G. B. B. CHAPLIN, M.SC., PH.D., *and* A. R. OWENS, M.SC.

The sensitivity of a d.c. amplifier using transistors is mainly limited by the variation of leakage currents and interelectrode potentials with temperature, the variation between any two temperatures being termed the thermal drift.

A typical low-frequency low-power transistor connected as an earthed emitter amplifier may have current and voltage drifts referred to the input of 50 μA and 100 mV respectively in the range 20° C to 500° C.

The use of two such transistors in a balanced circuit in which the drifts oppose but the signals add up reduces the net drift to about 1 μA and 2 mV if several adjustments are made. More time-consuming adjustments coupled with the use of selected transistors can reduce these drifts by several orders, but such a procedure is usually unacceptable.

The same transistor connected as a simple modulator operates with a fundamental current drift of only 3 μA but still has a voltage drift of 100 mV. It is thus most suitable for use with devices having a high source impedance such as an ionization chamber. The current error is reduced to 0·3 μA if a second transistor is used in a balanced circuit requiring only one adjustment.

Using the transistor in an earthed-emitter chopping circuit results in a current drift of 50 μA and a voltage drift of only 10 mV while reversing the functions of emitter and collector reduces these drifts to 3 μA and 100 μV respectively. This voltage drift is considerably less than that of most thermionic-valve amplifiers but the current drift is still large by thermionic-valve standards, limiting the chopper applications to low-impedance sources.

A modification to this chopper, however, eliminates the leakage current and leaves the voltage drift of 100 μV, which acts on the transistor impedance to produce a current drift of only 10^{-8} amp.

These latter drift figures are obtained without recourse to selection or balancing of transistors and are low enough to enable the transistor to contribute its many other advantages to such fields of applications as null detectors and analogue computers.

The use of higher-frequency transistors reduces the current drift still further to about 3×10^{-10} amp while the silicon junction transistor should enable direct currents lower than 10^{-11} amp to be measured.

A Decimal Adder using a Stored Addition Table *Paper* 2389 M: *Part B*

M. A. MACLEAN, M.SC., *and* D. ASPINALL, B.SC.

A serial decimal adder is described which accepts numbers in binary-coded form. The binary digits, which are handled in parallel, are decoded into a set of pulses which actuate a built-in addition table storing all the possible sums. A special form of number representation has enabled the adder to be constructed more economically than would otherwise have been the case, while the advantages of this type of adder have been retained.

The circuits use square-loop magnetic cores for all logical functions and junction transistors as pulse amplifiers.

A Magnetic-Drum Store for Analogue Computing *Paper* 2393 M: *Part B*

J. L. DOUCE, PH.D., *and* J. C. WEST, PH.D.

This paper describes how a conventional magnetic drum may be used in an analogue computer. The magnetic drum becomes a versatile element in this computer, giving a large storage capacity combined with a relatively short access time. Several of the important facilities obtainable by this technique are discussed.

Paper No. 2390 R, entitled 'A Flying-Spot Film Scanner for Colour Television', by H. E. Holman, G. C. Newton and S. F. Quinn, of which a summary appeared in the June Journal, p. 357, will be published late in July or early in August and not as previously announced.

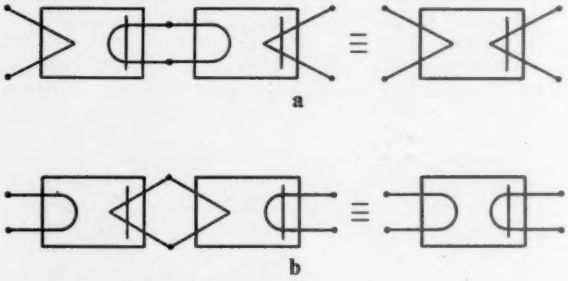
CORRESPONDENCE

IDEAL ACTIVE ELEMENTS

From G. E. SHARPE, B.SC.(ENG.), ASSOCIATE MEMBER*

Of the four transactor matrices G, H, Y and Z, given in Mr. A. W. Keen's letter in the April *Journal*, only the last two are fundamental. The G and H matrices may be derived from the Y and Z matrices as shown in the following paragraphs.

If a voltage-current transactor (v.c.t.) is followed by a current-voltage transactor (c.v.t.) a voltage-voltage transactor (v.v.t.) is obtained as shown in Fig. 1*a*.



1 *Derived transactors*

a Voltage-voltage transactor.
b Current-current transactor.

If a c.v.t. is followed by a v.c.t. a current-current transactor (c.c.t.) is obtained as shown in Fig. 1*b*.

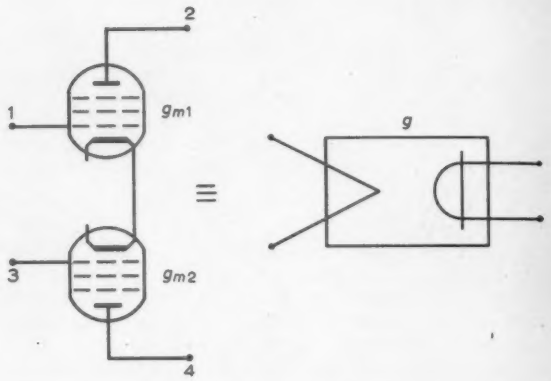
These elements correspond to those designated by Mr. Keen with G and H matrices and they have been called the derived transactors. The converse is not true; it is impossible to obtain a v.c.t. or a c.v.t. from the derived transactors. Voltage-to-voltage and current-to-current amplification is therefore not a fundamental form of activity.

In his table Mr. Keen lists eight examples of transactive elements, but his distinction is of electric connection and is not of a fundamental physical nature. Thus, *any one* of the transactors listed in the first four rows of the table would have sufficed as a fundamental definition of a v.c.t. I chose the one listed in the first row, because I follow Tellegen, Percival, Shekel and others in a preference for a symmetric notation. Dr. D. G. O. Morris in his letter in the May issue chose the transactor listed in the second row, because he prefers a cascade convention. Once, however, such a choice has been made, the elements in the remaining seven rows can be realized in terms of this element by suitable connection.

I was of course aware of the derivation of the three-terminal gyrator through the work of Shekel.[1] This derivation requires the use of positive and negative resistances and therefore fails to take full advantage of the transactor concept. I have shown in a recent letter[2] that positive and negative resistances are transactor derivable and may thus be considered to form passive and active transactor configurations. The fundamental significance of the transactors appears to be borne out by the fact that they give, as far as I know, the only theoretical prediction of the phenomenon of open and short-circuit stability of negative resistance.

The fundamental gyrator derivations given by Dr. Morris are in agreement with those given in an unpublished paper of my own, of which an extract now follows.

The v.c.t. may be physically realized by means of two



2 *Physical realization of the voltage-current transactor*

cathode-coupled pentodes as shown in Fig. 2. The transactor transconductance is

$$g = \frac{g_{m1}g_{m2}}{g_{m1} + g_{m2}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

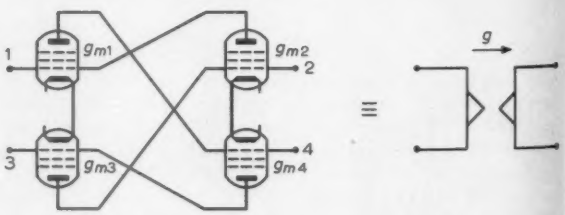
The symbolic derivation of the electric-electric gyrator is shown in Fig. 4*b* of Dr. Morris's letter. A realization by means of four pentodes is shown in Fig. 3, when

$$g = \frac{g_{m1}g_{m3}}{g_{m1} + g_{m3}} = \frac{g_{m2}g_{m4}}{g_{m2} + g_{m4}} \quad . \quad . \quad . \quad (2)$$

The device is lossless and acts as a gyrator. All connections shown carry alternating current, and the pentodes are stipulated to work within the linear parts of their characteristics. An actual working circuit of such a gyrator is shown in Fig. 4. When a positive voltage v_{13} is impressed between terminals 1 and 3, v_{24} will appear positive; conversely, if v_{24} is driven positive, v_{13} will appear negative.

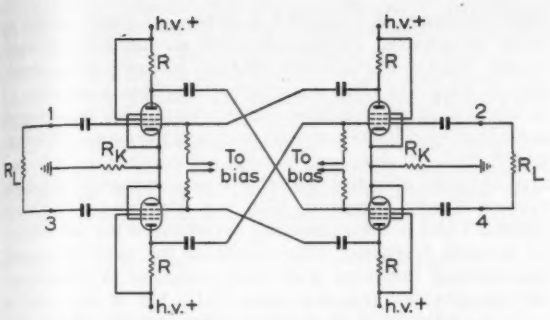
Provided $R \gg R_L/2$ the gyrator is effectively loaded by R_L, and resistors R may be neglected when dealing with alternating current.

Resistor R_K provides a path from the negative terminal of the d.c. supply to the cathodes of the valves.



3 *Physical realization of the electric-electric gyrator*

* Mr. Sharpe is with British Telecommunications Research, Ltd.



4 *Working circuit of the electric-electric gyrator*

Provided $R_K \gg 1/(g_{m1} + g_{m2})$ the conditions given in eqns. (1) and (2) are deemed to apply, and R_K may be neglected when dealing with alternating current.

Dr. Morris's last point is conceded. It appears that every network can be constructed with recourse to only three fundamental network elements. Nevertheless, out of a feeling for symmetry I included both the inductor and the capacitor in Fig. 3 of my original letter.

Finally, I should like to correct the following serious mistake in my original letter. The fourth 'law' to be obeyed by an ideal active element was incorrectly given and should read as follows:

Definition

(*d*) An element is maximum-active if it supplies maximum power to a stable load.

Activity

An ideal active element must consist only of parts which contribute to its activity, and these parts must be maximum-active.

1 SHEKEL, J.: 'The Gyrator as a 3-Terminal Element', *Proceedings of the I.R.E.*, 1953, **41**, p. 1014.

2 SHARPE, G. E.: 'Transactors', *ibid.*, 1957, **45**, p. 692.

SOME RECENT BOOKS

S. W. AMOS and D. C. BIRKINSHAW

TELEVISION ENGINEERING PRINCIPLES AND PRACTICE. Vol. III. Waveform Generation

LONDON: ILIFFE. NEW YORK: PHILOSOPHICAL LIBRARY. 30s.

This third volume of the series by Amos and Birkinshaw follows closely the general style of Volume II on video amplification.

The reader is introduced in Part I to the simpler waveforms used in television and is shown how they are related mathematically and how they are utilized in circuits.

Part II deals briefly but adequately with the generation of sine waves, and in a simple mathematical appendix the circuit impedance relations of a basic three-terminal negative-resistance oscillator are derived.

The generation of rectangular waveforms receives the most comprehensive treatment in Part III, and does in fact occupy about half of the complete volume. Monostable, bistable and astable multivibrators in anode-coupled and cathode-coupled form are dealt with in some detail. Circuit design and operation are covered with particular reference to triggering methods. This part of the book, which also deals with single-valve generators of the transitron and phantastron types, represents one of the most complete reviews of this subject yet available in a simple form and should be completely acceptable to the student. The most notable omission in this part of the book is the use of delay-line technique in rectangular-wave generators.

Part IV deals with the generation of sawtooth waveforms and includes the simple classic types, the blocking oscillator, the multivibrator, the Miller integrator and 'bootstrap' types. A number of simple numerical designs are included, which should help the student to appreciate the merits of the designs discussed.

The fifth, and last, part, which is very short, deals with the generation of parabolic waveforms and their uses.

The authors have no doubt been exercised in deciding what to include in this volume and what to leave to Volume IV, and no doubt the obvious omissions in waveform-generation technique can legitimately be dealt with under the classification 'circuit technique'. It was a little disappointing, nevertheless, to finish the book and realize that the generation of the composite television waveform had not been discussed. Certain other composite test waveforms (such as the stepped sawtooth, used currently for linearity checking) have also been omitted.

As a training manual this volume can be recommended with confidence, and there is no doubt that despite the omissions recorded it will be used widely both as a training manual and as a reference book by many practising engineers. We look forward to Volume IV with interest.

J. G. CROWTHER

NUCLEAR ENERGY IN INDUSTRY

NEWNES. 175 PP. 17S. 6D.

This book, which was published towards the end of 1956, is a very readable account of nuclear energy and its applications. 'Industry' in the title must be interpreted in its widest sense; for the contents stretch considerably further than the field of application of nuclear energy to the electrical supply industry and to manufacturing industry in general, as the following seven chapter headings illustrate: The Impending Revolution; What is Nuclear Energy?; Various Kinds of Reactor; Nuclear Power; Isotopes in Industry; Winning Uranium; The New Metallurgy and Technology.

The first chapter deals with humanity's coming escape from bondage through the agency of plentiful mechanical power. In changing from animal power based on vegetation to engine power based on fossil fuels, man has exchanged a stable for an unstable energy basis of society. Fossil fuel reserves are not unlimited and rates of usage and probable extent of reserves therefore settle the possible duration of

this pattern of existence. Nuclear fission energy provides an escape from this impasse.

In the second chapter the author recounts the evolution of nuclear physics from the discovery of radioactivity to the discovery of nuclear fission and the chain reaction. The essential functions and functioning of diffusion plants and nuclear reactors are also covered.

Chapter III discusses the Harwell experimental reactor known as BEPO, the American swimming pool reactor and the Canadian heavy-water experimental reactors NRX and NRU. Chapter IV contains descriptions of the first atomic power station built in the U.S.S.R., the Calder Hall project, the Dounreay fast reactor, the Harwell reactors Zephyr and Zeus, and the American Shippingport project. The author also mentions the Nautilus, boiling-water and homogeneous aqueous reactors and the liquid-metal fuel reactor.

The chapter on isotopes describes the use of tracers for measuring wear, the movement of fluids in pipes and in the ground, mass transfer in molten metal and many other applications.

Chapter VI gives a very readable account of prospecting and mining for uranium, while in the last chapter Mr. Crowther describes the processing of metals important in nuclear engineering—uranium, thorium, beryllium, zirconium—the manufacture of graphite and heavy water, and some of the health precautions necessary in atomic energy plants.

The book is addressed to the layman as much as to those with scientific knowledge, but there is no 'writing down'. Science masters would find it particularly useful for sixth-form reading. Indeed the book covers a large amount of ground in a lucid style and forms an excellent introduction to the subject of its title.

E. HÖLZLER and H. HOLZWARTH

THEORIE UND TECHNIK DER PULSMODULATION (THEORY AND TECHNIQUE OF PULSE MODULATION)

BERLIN: SPRINGER-VERLAG. 519 PP. £4 15S. APPROX.

In this volume the authors have collected a mass of information covering all aspects of pulse-modulated communication systems. The treatment is developed logically from the classic methods of continuous amplitude, phase and frequency modulation. The first of the six chapters reviews these older methods, developing expressions for the spectra and analysing the distortions that may arise and the effects of noise in each system. Multiplex systems are discussed, and the methods of pulse modulation are introduced.

Chapter 2 is devoted to a study of fundamental laws. It contains very detailed treatments of spectrum analysis by Fourier series, synthesis of non-periodic from periodic functions, sampling theorems, network distortion and response, spectra of amplitude, duration and frequency-modulated pulses, and the distortion due to quantization. The third chapter deals with practical circuits, which include, besides differentiating and integrating circuits and generators of pulses and other waveforms (with which the student may already be familiar), many circuits specially developed for this field, such as time filters.

Chapter 4 discusses the distortion arising in the transmission system, and covers network transfer functions, amplitude and phase response, linearization of phase delay, and crosstalk in multiplex systems, using the different methods of modulation. In Chapter 5 the treatment of signal/noise ratio introduced in Chapter 1 is elaborated and extended to pulse modulation. Figures of merit are derived for each system, and the improvement obtained by compandor operation is discussed. The last chapter describes a number of circuits for generating pulses distributed in time sequence to a number of channels, as well as modulators and detectors, coders and decoders, and circuits for converting from one type of modulation to another. The construction of complete systems is also described, with examples of a 12-channel system. There is a mathematical appendix on the calculation of network responses, with graphs of the most frequently encountered functions and their integrals. A seven-page bibliography, an adequate index and a list of the symbols used are included. A good balance has been struck between readability and mathematical completeness, and, while the authors have not hesitated to include the mathematical treatment necessary to develop the formulae and make comparisons between the various systems, they have kept it to a minimum and at a level that should be well within the grasp of the practising engineer or of the student who has a reasonable background in electronics. English-speaking readers with a moderate knowledge of German should find the text straightforward and readable, and for those who intend to specialize in the field the volume will constitute a valuable grounding in both theory and practice.

E. W. KIMBARK

POWER SYSTEM STABILITY, VOL. III. SYNCHRONOUS MACHINES

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 331 PP. £4.

This book on synchronous machines is the third of three volumes on power-system stability, of which the first explains the normal practical methods of calculating the stability limits of a system and the second discusses switches and relays. It might be thought that, since the alternators are the most important components of any power system, they should be covered in Vol. I rather than in Vol. III, and that would perhaps be the more logical arrangement. However, the usual methods of analysing transient stability make such drastic simplifying assumptions about the alternator that the machine characteristics need not be considered in any detail for that purpose. The arrangement used is less satisfactory for steady-state stability and has the effect of postponing the detailed discussion of this topic until the last chapter of Vol. III.

The synchronous machine and its excitation system is in fact much more complicated than the usual simplified representation, and the new volume is devoted mainly to examining the effects of these complications. They are discussed separately under such headings as saturation, saliency, flux decrement, damping, voltage regulation and governing, and approximate methods for dealing with each are explained and illustrated. There are many practical comments on the value of the results obtained. Usually the conclusion is that the simple methods are adequate, although their adequacy is becoming more doubtful as time proceeds. Nothing is said in the book about the methods, which have received a good deal of attention in recent years, of obtaining a more accurate simulation of the synchronous machines on a network analyser.

The author takes considerable pains to present the theoretical matter in a simple way, and the book appears to be directed primarily to graduate students with little previous knowledge of the subject. All the material included is valuable in itself

and is clearly explained, but there is some lack of balance in relation to the subject of power-system stability, both in the selection of topics and in the space given to each. For example, a long section in the chapter on excitation systems is devoted to the calculation of exciter response curves, but little is said about the operation of closed-loop control systems.

For simplicity the derivation of Park's equations is given for a machine without damper windings. This makes it easier to follow the working but more difficult to understand how the sub-transient reactances and time-constants arise. On the other hand, the equations allow for a quadrature-axis field winding, although this type of winding is hardly ever used in practice. The analysis could possibly apply to a quadrature damper circuit, but it would not then be true, as stated on page 113, that 'T'_q is about half of T'_d'; nor would $x'_d = x'_q$.

The final chapter on steady-state stability develops the subject in a very logical manner and shows clearly what assumptions are made in dealing with its different aspects. The discussion of the effect of voltage regulators on steady-state stability is very brief.

LIBRARY ACCESSIONS

**Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members.*

ADKINS, B. 621.313

The General Theory of Electrical Machines*

London, Chapman and Hall, 1957. pp. ix, 236. 22 × 14 cm. £2 5s.

This book, intended for advanced students and design engineers, is a mathematical treatment of the subject. It will be reviewed in a future issue.

FABER, O., and KELL, J. R. 697

Heating and Air Conditioning of Buildings. 3rd ed.

London, Architectural Press, 1957. pp. xii, 611. 23 × 15 cm. £3 5s.

An authoritative and comprehensive survey of systems for domestic, commercial, and industrial premises containing much practical data. This edition includes accounts of high-temperature radiant panels, heated acoustic ceilings, high-velocity air distribution, and other developments since 1943, when the previous edition was published.

FINK, D. G. (Editor) 621.397

Television Engineering Handbook

London, McGraw-Hill, 1957. pp. xiv, 1600. 24 × 16 cm. £5 12s. 6d.

Covers monochrome and colour systems and the systems and standards of the United States, Britain, France and C.C.I.R. groups. Gives detailed up-to-date design data for receivers, and covers, in addition, transmission questions, cameras and related equipment, lines and transmitters. This book will be reviewed in a future issue.

FITZGERALD, A. E., and HIGGINBOTHAM, D. E. 621.313

Basic Electrical Engineering Circuits, Machines, Electronics, Control. 2nd ed.

London, McGraw-Hill, 1957. pp. xi, 540. 24 × 16 cm. £2 16s. 6d.

This book covers the whole field of a.c. and d.c. circuits, machines, amplifiers and measurement. An elementary introduction is followed by a more advanced treatment leading up to feedback systems and control circuits.

HENISCH, H. K. 621.314.6

Rectifying Semi-Conductor Contacts*

Oxford, Clarenden Press, 1957. pp. xii, 372. 24 × 16 cm. £3 10s.

A book mainly for physicists who require a specialized knowledge of semi-conductor contacts and related surface phenomena.

HOLMSTROM, J. E. 001.8

Records and Research in Engineering and Industrial Science. 3rd ed.

London, Chapman and Hall, 1956. pp. xii, 491. 22 × 14 cm. £3.

A discussion of scientific research and its applications is followed by a list of societies and other related organizations in this country and abroad. Methods of recording, storing and retrieving information are described.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS 697

A Guide to Current Practice

London, Institution of Heating and Ventilating Engineers, 1955. pp. 424. 25 × 16 cm. £3 3s.

This reference guide consists of three sections. Data on heat requirements, water services, combustion, fuels, ventilation, air conditioning, electrical equipment, automatic control, regulation, etc. A subject and author index to papers published (1899–1954) in the 'Proceedings' and the 'Journal of the Institution of Heating and Ventilating Engineers.' A catalogue of manufacturers' products.

LABOVITCH, C. 37

Directory of Opportunities for Graduates 1957

London, Cornmarket Press, 1957. pp. 159. 22 × 14 cm. 7s. 6d.

Gives brief descriptive details of the size, scope, activities and products of a considerable number of organizations, followed by an indication of the types of graduate required—arts, science, engineering—and the nature of the work, training, location, and salary scheme.

MARROWS, H. E. 621.314.7

Transistor Engineering Reference Handbook

New York, Rider, 1956. pp. viii, 278. 31 × 24 cm. £4.

Surveys the present position in the development of transistors, the various types and their commercial applications. Gives characteristic curves and performance data, of 200 commercial types, and the physical and electrical properties of over 200 types of transformer, 450 capacitors and 100 cells and batteries designed for use with transistors. Circuits for commercial applications are also shown.

MELLANBY, J. 93 : 621.31

The History of Electric Wiring*

London, Macdonald, 1957. pp. xiii, 244. 23 × 14 cm. 32s. 6d.

Traces progress in wiring from 1870 to the present, dealing also with accessories and their evolution. The inventiveness of Crompton, Kelvin, Swan, Edison and other personalities is described. There are many interesting illustrations, a bibliography and an index.

MILLER, K. S. 517

Engineering Mathematics

London, Constable, 1956. pp. viii, 417. 23 × 16 cm. £2 7s. 6d.

Deals with determinants and matrices, integrals, linear differential equations, Fourier series, the Laplace transform, network theory and random functions.

MITCHELL, R. W. S. (Editor) 621:744

Drawing Office Handbook. 3rd ed.

London, Pitman, 1956. pp. viii, 423. 22 × 14 cm. 16s.

Contains extracts from a number of British Standard specifications, including information on limits and fits and drawing office practice. Covers gear design, welding, lubrication, vibration and noise, electrical technology and electronics and deals briefly with photocopying and with patent law.

STARR, C. H. 658.7

The Specification and Management of Materials in Industry

London, Thames and Hudson, 1957. pp. xii, 194. 22 × 14 cm. 21s.

Draws attention to the savings resulting from good materials engineering, and advocates a central department for this purpose. Discusses standardization, purchasing and inspection, and deals in detail with specifications for purchasing and for processing materials, and for purchasing components.

NYE, J. F. 548

Physical Properties of Crystals. Their Representation by Tensors and Matrices

Oxford, Clarendon Press, 1957. pp. x, 322. 24 × 16 cm. £2.

Gives a unified and systematic presentation of the tensor properties of crystals, explaining their common mathematical basis and the thermodynamic relation between them.

SCHURE, A. (Editor) 621.396.615

L-C Oscillators

New York, Rider, 1957. pp. vi, 66. 22 × 14 cm. 10s.

A brief account of oscillatory circuits for low, medium and high frequencies.

SCHURE, A. (Editor) 621.396.615

Resonant Circuits

New York, Rider, 1957. pp. vi, 66. 22 × 14 cm. 10s.

A simple introduction to the theory of resonance and coupled circuits.

Contents of the Current Issues of the *Proceedings*

DATE OF JOURNAL REVIEW OR SPECIAL ARTICLE

PART A. POWER ENGINEERING (JUNE 1957)

See *Journal*, June 1957, p. 359.

PART B. RADIO AND ELECTRONIC ENGINEERING (JULY 1957)

Written discussion on **Fading of Long-Distance Radio Signals, and a Comparison of Space- and Polarization-Diversity Reception in the 6–18 Mc/s Range**

Discussion on **Computer Input and Output, including Analogue-Digital Conversion**

C. E. RICHARDS, E. V. WALKER, B.SC., AND A. C. LYNCH, M.A., B.SC.
May 1957 **An Experimental Study of High-Permeability Nickel-Iron Alloys** (PAPER NO. 2136 M, AUGUST 1956)

A. C. LYNCH, M.A., B.SC.
May 1957 **A Method for the Precise Measurement of Permittivity of Sheet Specimens** (PAPER NO. 2208 M, OCTOBER 1956)

A. C. LYNCH, M.A., B.SC.
May 1957 **A Bridge Network for the Precise Measurement of Direct Capacitance** (PAPER NO. 2209 M, OCTOBER 1956)

W. F. LOVERING, M.SC., AND D. B. BRITTEN, B.E.
May 1957 **A Simple Transformer Bridge for the Measurement of Transistor Characteristics** (PAPER NO. 2247 M, DECEMBER 1956)

C. S. BULL, PH.D.
June 1957 **The Capacitance between Diode Electrodes in the Presence of Space Charges** (PAPER NO. 2333 R)

M. E. HAINE, M.SC., AND M. W. JERVIS, M.SC.TECH.
April 1957 **The Ultimate Performance of the Single-Trace High-Speed Oscillograph** (PAPER NO. 2306 M, JANUARY 1957)

M. E. HAINE, M.SC., AND M. W. JERVIS, M.SC.TECH.
April 1957 **The Design and Performance of a New Experimental Single-Transient Oscillograph with Very High Writing Speed** (PAPER NO. 2307 M, FEBRUARY 1957)

Discussion on **The Crystal Palace Television Transmitting Station** before the South Midland Centre and the Northern Ireland Centre

J. R. A. BEALE, B.A., W. L. STEPHENSON, B.SC., AND E. WOLFENDALE, B.SC.
Not yet reviewed **A Study of High-Speed Avalanche Transistors** (PAPER NO. 2367 R)

PROFESSOR H. E. M. BARLOW, PH.D., B.SC.(ENG.)
July 1957 **Propagation of the Circular H_{01} Low-Loss Wave Mode around Bends in Tubular Metal Waveguide** (PAPER NO. 2369 R)

W. J. POHL, M.SC.
July 1957 **The Design and Operation of High-Power Triodes for Radio-Frequency Heating** (PAPER NO. 2379 R)

PART C. MONOGRAPHS (MARCH 1957)

See *Journal*, March 1957, p. 187.

BRITISH STANDARDS

Copies of the following publication can be obtained from the British Standards Institution, 2 Park Street, London, W.1. The price given is post free.

B.S. 1858: 1957 **Bitumen-base Filling Compounds for Electrical Purposes** 7s. 6d.

This revision of B.S. 1858: 1952 applies to bituminous compounds used as filling compounds which are subjected to electrical stress in service. The methods of test are based as far as possible on the 'Standard Methods for Testing Petroleum and its Products', published by the Institute of Petroleum.

E.R.A. REPORTS

Copies of the undermentioned E.R.A. Reports can be obtained from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. The price of each report is given, and, unless otherwise stated, the cost of postage on a report is 4d.

C/T115 **Wind Data Related to the Generation of Electricity by Wind Power** by J. R. Tagg. 30s. (POSTAGE 7D.)

The report describes the results obtained from a wind survey of Great Britain and Ireland. Its purpose was to assess the potentialities of the wind as a source of electrical energy. Initially, the survey covered the western and south-western coastlines, but later, to complete the study of winds over the whole country, several sites on the east coast were included.

The results of these measurements are analysed and presented in both tabular and graphical form.

A section dealing with the results of wind measurements in other countries is included to help in assessing the potentialities of wind power oversea, and to compare different wind regions.

C/T118 **The Combination of Local Energy Resources to Provide Power Supplies in Under-Developed Areas** by E. W. Golding. 21s. (POSTAGE 6D.)

This report is based on a paper prepared for a conference under the title 'Journées Internationales de l'Électricité dans les Pays Tropicaux' held in Paris in May 1956, but a number of modifications and extensions have been made to render the subject-matter more generally applicable to under-developed areas. It is concerned particularly with the problem of providing power and amenities in areas where remoteness from main power stations and from fuel supplies renders the use of conventional methods of power generation prohibitively expensive. The possibilities of utilizing local energy resources such as wind, solar radiation and waste organic matter are discussed, and recent developments of equipment using these forms of energy are reviewed.

F/T188 **Current Carrying Capacity of Small Cables for Domestic and Small Commercial Installations** by R. G. Parr. 12s. 6D. (POSTAGE 6D.)

This report describes tests carried out to determine the current-carrying capacity of small cables used for domestic and commercial installations. Current ratings corresponding to a 16·7° C (30° F) temperature rise are given for four sizes of cable with different coverings and modes of installation, run in single-, double-, three- and four-circuit groups. The average relation between temperature rise and current for the several types tested is given to permit calculation of the current rating corresponding to any other temperature rise.

F/T191 **Current Ratings and Impedance at 50 c/s and at 400 c/s of 3-Core Paper-Insulated Lead-Covered Single-Wire Armoured Cables and Single-Core Vulcanized-Rubber Insulated Cables in Steel Conduit** by R. G. Parr. 10s. 6D.

This report gives experimentally determined current ratings at 50 c/s and at 400 c/s for 660-volt 3-core paper-insulated lead-covered single-wire armoured unserved cables (conforming to B.S. 480: 1942) in air, and for three single-core v.r.i. cables, taped and braided (to conform to B.S. 7: 1946) run in heavy-gauge screwed conduit in air. Ratings are given corresponding to the temperature rises of 45°, 50° and 55° C for paper-insulated cables and 20° C for v.r.i. cables. The information given can be used to cover other temperature rises of the same order.

G/T304 **The Effect of Series Resistance on the Ignition of Methane-Air Gas Mixtures by Capacitive Discharges** by H. G. Riddlestone. 7s. 6D.

The effect of series resistance on the stored energy required to ignite 8·35% methane-air mixtures by capacitive spark discharges has been described in Report Ref. G/T278 for circuits in which the values of capacitance and resistance were less than 850 $\mu\mu$F and 60 ohms respectively. The range of the measurements has now been extended to include capacitances up to 1 μF and resistances up to 225 000 ohms, with both tungsten and steel electrodes.

Measurement of the actual discharge energies required for ignition with this increased range of circuit conditions has not yet been carried out, but the scope of the present techniques of oscillographic recording of the discharge currents and voltages is being widened to make this possible.

G/T307 **A Four-Channel Cathode-Ray Oscillograph with Automatic Brilliance Control** by M. T. Cree. 6s.

The Duddell vibrator has two outstanding advantages, namely simplicity and high sensitivity to voltage, which have resulted in its wide use in oscillographs for recording transients on power systems. Its main disadvantages, i.e. a poor high-frequency response, low impedance, and its need of an intense light source, have prompted the E.R.A. to construct an oscillograph for this class of work, using small low-voltage cathode-ray tubes. The speed of the film or recording paper is of the same order as that usual with electromagnetic oscillographs, i.e. 200 inches/sec.

Experience has shown that the high-frequency response of the cathode-ray tube is not wasted, because pulses too short to be recorded by a Duddell vibrator are recorded by vertical lines indicating their presence and amplitude.

L/T329 Electrical and Optical Characteristics of D.C. Corona Discharges in Air at Atmospheric Pressure by B. Murphy. 21s. (POSTAGE 6D.)

D.C. positive-point-to-plane corona discharges in untreated room air have been studied with the aid of a photo-multiplier, wide-band (distributed) amplifiers and a high-speed cathode-ray oscillograph.

The results indicated that a pulsed form of discharge did not necessarily occur. When a pulsed form did occur, the pulses were associated with streamers propagated from the positive point towards the negative plane. Direct evidence was obtained that some ionization and considerable excitation occurred ahead of and around, the streamers. Streamers did not branch until after they had begun to decay. Branches did not propagate simultaneously. This accounted for the characteristic visual form of the self-maintained positive-point corona discharge in air.

L/T336 Life-Testing of Impregnated Paper Capacitors: Variability of Results by H. F. Church. 7s. 6D.

It is shown by a statistical analysis of a large amount of existing data that the observed wide variability of d.c. life-test results on impregnated-paper capacitors can be explained in terms of the geometry of the dielectric. The statistical distributions of short-time d.c. breakdown stress and of life under normal stress conditions are related to the same geometrical considerations, and the practical implications of this are discussed.

The effects of capacitor size on life and variability are also considered.

L/T338 Polarization of the Continuous Spectrum in a Gas Discharge by B. V. Paranjape. 6s.

It is shown theoretically that the continuous part of the spectrum of a gas discharge is polarized. Measurement of polarization is shown to be of use in estimating either the electron temperature or the number of free electrons per unit volume, since polarization can be expressed in terms of the latter quantities. The treatment of electron temperature is similar to that in solids (cf. Refs. L/T277, 285 and 307).

L/T342 On the Polaron Rest Energy and Effective Mass by G. R. Allcock. 21s. (POSTAGE 6D.)

The work to date on polarons* is collated and summarized. When the coupling is strong, simple considerations can be applied enabling one to relate the results of various authors. From these considerations the form of the rest energy is derived.

T/T54 Nomographic Representation of Elastic Contact Conditions between Steel Pivots and Sapphire or Diamond Jewels by G. F. Tagg. 6s.

Nomograms are given in report Ref. T/T39 for the static elastic conditions between a steel pivot and a sapphire jewel, and in Ref. T/T48 for conditions of impact. It has been suggested that it would be useful to have the two major nomograms reproduced in a convenient form, and they are printed in this report.

U/T135 Oscillographic Observation of Short Duration Arcs between Separating Platinum and Palladium Contacts by J. Riddlestone. 12s. 6D.

Preliminary records of arc voltages of very short duration between separating contacts have been obtained with the E.R.A. ultra-high-speed oscillograph. The contacts were operated under the same conditions as those used for the transfer measurements described in Reports Ref. U/T130 and U/T133. The closed-circuit currents were 4·5 amp and 8 amp for platinum and 4·5 amp for palladium contacts, the supply voltage was 6 volts and the effective inductances ranged from $<0{\cdot}1\,\mu$H (the minimum) to $4{\cdot}7\,\mu$H.

The limitations of the method of obtaining the records are discussed, and the need for development of more efficient methods is stressed. There is insufficient evidence from the records on which to base a theory of the arc at separation or a relationship between transfer and characteristics.

* The term *polaron* is explained in the report.

Annual Report

The 36th Annual Report of the British Electrical and Allied Industries Research Association for the year 1956 has recently been published. It lists and describes all the reports issued by the Association during that year and gives brief accounts of the progress of research carried out in the various sections.

ECONOMIC COMMISSION FOR EUROPE

Rural Electrification, Vol. 2 7s.

The first volume of ten papers dealing with various aspects of rural electrification was published last year and briefly described in the December issue of the *Journal*, p. 768. A second volume of six papers, in English, compiled by specialists from five European countries has now been published. The papers are based upon information supplied by many countries, and the subjects covered are the use of the ground as a conductor, electric tractors, the expansion of rural networks, financing of rural plant, propaganda methods, and electrified spraying plant. The object of this study by the United Nations Economic Commission for Europe is to make available to all countries the varied experience gained by others.

The Electric Power Situation in Europe in 1955 3s.

This publication, recently issued by the United Nations Economic Commission for Europe, is intended to provide comparable background data for studies on the electrical power situation in Europe. The figures have been supplied by governments in response to the Secretariat's annual inquiry.

Copies of the above two publications may be obtained from the Sales Section, European Office of the United Nations, Palais des Nations, Geneva, Switzerland.

MINISTRY OF WORKS

Ring Circuit Electrical Installations for Housing by C. A. Farr. 6D.

A booklet describing the use of ring circuits in private houses has been published recently by the Stationery Office on behalf of the Ministry of Works. It is one of seven booklets prepared for architects and builders and their clients, reviewing modern techniques that merit wider use. The booklet is a simple, concise and very readable survey of modern practice, and it details the advantages that ring circuits have over traditional methods. These include lower cost, a saving of valuable materials, greater safety, and the provision of adequate power points for modern needs.

The booklet may be purchased from Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2, or through any bookseller.

Elections and Transfers

The following elections and transfers approved by the Council are effective from the 23rd May 1957.

ELECTIONS

Graduates

BIBBECK, Thomas Crosby
BLACKWELL, Kenneth John
BROADHURST, Neville Buckley
CALVESBERT, James William
CAREY, Peter Herbison
CLAYSON, Peter John, B.ENG.
DARKE, James Anthony, B.SC.(ENG.)
DAWSON, Alan Victor
DAY, Neville
DHAR, Prateep Mohan, B.SC., B.A.
FORD, Derek Vincent
FRANKS, Peter Lewis
GAGNE, Roland Ernest, B.SC.
GARG, Sudershan Kumar
GARRETT, John
GRAHAM, Edward Westholm, B.E.
HALL, John Alan
HARRILD, Robert Thomas, B.SC.(ENG.)
HAYES, John Rigby
HODGES, William Lawrence
HOLBEN, John Christopher
HOLLAND, Peter Henry
HUGHES, Alan John
JACKMAN, Alan Rowland
JOHNSON, Kenneth Hamilton
JONES, Royston Everard
KOTTARIS, Spyridon
LUND, Kenneth George, B.SC.
MAXWELL, Arthur Henry
MIRZA, Hasan, F.SC., LL.B.
NETTEY, Cyril Francis
O'REILLY, Michael Joseph, B.E.
PRESTON-THOMAS, Dosde Grant, B.E.
PRICE, Kenneth James
PURSEY, Gerald Edward
RUST, William
SANDERS, Robert George
SIM, Ronald
STEELE, Malcolm Stuart
STUTTING, Roy
TAYLOR, John Graham, B.A.
THOMPSON, Charles Douglas
VIPPOND, Frederick George
WATSON, Michael Frank
WHITFIELD, Samuel Jeremy Mackay, B.SC.(ENG.)
WILLIAMS, William George
WORRALL, John

Students

ACORNLEY, Michael Ritson
ALSTEAD, Geoffrey Carl
ALWAN, Mohamed Baker
ANDREWS, David Keith, B.SC.
ASHPOLE, Frederick Viljoen
BALMBRA, Peter Aherne
BENSON, Collen Clive, B.SC.
BROOKE, Colin
BROWN, Raymond John
CASSELS, William Robert
CHADWICK, Geoffrey Alan
COLLIS, Milne Walter
DELLOW, John Brian
DE SOUZA, Robert Michael
DUROSE, Peter Vernon
EASTLAND, Martin Howard
EDGE, Gordon Malcolm
EGLINTON, Malcolm Oliver
ELLIS, Alan Gordon
FOSS, Richard Charles
GLOVER, Michael Keyworth
GRESZCZUK, Jozef
HADEN, Donald Sydney
HODGSON, Alan
HOLLOWAY, David Harold
JONES, David Gareth James
LAMBERT, Walter Oliver
LE CLUE, David
LEMMON, Anthony William
LEYLAND, Bryan William
LOCKTON, Michael Harry, B.A.
LOUGHRAN, James Bernard
MCNUTT, Barry Herbert
MUIR, Neil David
MÜLLER, Eugene Douglas
NORMAN, Michael Douglas
ONYEJIZU, Raphael Nwafor
PARK, Stephen Sutcliffe
PHILADELPHIA, James Lambert
PONHUSAMY, Surendra
POWELL, Bernard George
RODDY, Gerald Francis
SAVAGE, Brian Matthew
SHEEHAN, Vincent Anthony
STEVENS, Alan James
VALENTINE, James Grenville
WAIDYATILLEKE, Ananda Jayatilleke
WALLACE, James Peter
WAYE, Jack
WHITE, Raymond Anthony
WRIGHT, Robert Frederic John

TRANSFERS

Student to Graduate

BOUSFIELD, Gerald Harker
BOXALL, Herbert, B.SC.
BRADBURY, Kenneth John, B.SC.(ENG.)
BRIERLEY, Geoffrey Armitage, B.SC.(ENG.)
BURTON, Geoffrey, B.SC.
CLARRICOATS, Peter John, B.SC.(ENG.)
COHEN, Allan, B.SC.(ENG.)
COLBURN, Peter John, B.SC.(ENG.)
COLLINS, Geoffrey Bernard, B.SC.(ENG.)
COOPER, David, B.SC.(ENG.)
DAVIES, David, B.SC.
DENISON, Norman Estall, B.SC.(ENG.)
EPPS, Robert Martin
FRASER, Alexander Hugh Campbell, B.SC.(ENG.)
HALLEWELL, Charles Hew Christopher
HARRISON, Peter Feather, B.SC.
IRVINE, Alastair Munro, B.SC.(ENG.)
MARLAND, Lt. Henry Sydney, B.SC., R.N.
O'SULLIVAN, Maurice Anthony, B.E.
RICHMOND, Eric Ivor, B.SC.(ENG.)
ROBINSON, Peter Antony, B.SC.(ENG.)
STRONGMAN, Sub.-Lt. Charles Percival, B.SC.(ENG.), R.N.V.R.
SWIFT, Pilot Officer Donald Arthur, B.SC., R.A.F.
SYKES, David John, B.SC.
THOMAS, Norman Arthur
TUCKER, Michael John
WALLBUTTON, Bernard Charles
WOOD, Keith William, B.SC.(ENG.)

The following elections and transfers approved by the Council are effective from the 1st June 1957.

ELECTIONS

Associate Members

ATKINS, Ernest Raymond Morley
BIGGS, Stanley Sutton, M.A.
BELL, John Dugald
BRION, Edwin Alfred

Associate Members (contd.)

BROWN, Henry
CONWAY, Ronald Hall
DRYSDALE, Henry, B.SC.
GORE, Gerard Werner, B.E.
HOWLETT, Jack, B.SC., PH.D.
JONES, Thomas Roderick
LARGE, Frederick Edmund
PEDDER, Michael Charles Calvert, B.SC.
RIPLEY, Benjamin Dobson, B.SC.
SAMUELS, Frederick Leslie Norman, B.SC.(ENG.)
TINGATE, John Bruce, B.E.

Associates

BATES, Arthur Leslie
BOURNE, William George
DEB, Sudhansusekhar, B.SC., D.PHIL.
TURNER, Eric Herbert William
WOOD, Alfred William, D.F.C., B.E.M.

TRANSFERS

Associate Member to Member

ARNOLD, Harold Edwin
ASBURY, Allan, B.SC.
ASQUITH, Ernest
COWAN, James MacMillan, DR.ING., B.SC.
CUNNINGHAM, John Francis
EDMONDS-BROWN, Capt. Harold Edward, M.B.E., R. Signals
ESCOTT, Alexander John
FIRTH, John Alfred Patrick
FREEBODY, John William Henry, B.SC.(ENG.)
HILES, Eric James
HUNT, George James
JONES, Francis Edgar, M.B.E., B.SC., PH.D.
KNOX, John, M.SC.
LAW, Lionel William, M.A.
MONAHAN, Thomas Francis, B.SC.
OLDHAM, Hugh William, M.A.
OOMMEN, Adangaprathu, B.A., B.SC.
PRICE, Edward Michael, M.A.
SAGEMAN, Walter John

Associate to Associate Member

COLLINGHAM, Robert Alfred, B.SC.(ENG.)

Graduate to Associate Member

APPLEYARD, Albert Henry
ARLOW, James
ATKINSON, Norman
BORTHWICK, John Burnett, B.SC.
BRATT, Peter, B.SC.
BULLOCK, Kenneth Reginald, B.ENG.
CHAMPION, Lt. Ronald Albert, B.SC.(ENG.), R.N.
CLEGG, Kenneth Alan
COOPER, Capt. Donald William Walmsley, R. Signals
DAVIES, Evan John, B.SC.
DAVIES, Philip Edward
DOUGLAS, John Lunn, B.SC.(ENG.)
DUTTA, Amal Kumar, M.SC.
EATON, Claude Richard
EDWARDS, Alan
ETCHELLS, Roy, B.ENG.
FALL, Geoffrey Albert
FAWCETT, Jack
GRIFFITHS, Edward Eyres
HANCOCK, William Thomas Marshall
HARRY, Leslie Howell, B.SC.(ENG.)
HODGES, Robert James
HUNT, John Edward Peter
JONES, Douglas George Henry
KIDD, Jack, B.SC.(ENG.)
KINNEAR, John Alexander Christie, B.A.
LEWIS, David Goronwy Terrence, B.SC.
MACDOWALL, Thomas Edward Gillies, B.SC.(ENG.)
MACPHERSON, Ian Keith, B.SC.(ENG.)
NASH, Frank Joseph, B.SC.
NASH, Robert William, B.SC.
NEWBY, Thomas Hobbs
PANTLIN, Harold Norman
PERKS, Joseph Thomas
READ, Mark Edward Adrian
ROBERTSON, Victor Stanley, B.SC.(ENG.)
ROWE, Michael Paul Norris
ROZANSKI, Andrzej, DIPL.ING.
SAUNDERS, Peter John
SCHUELER, Charles David
SCOTT, Trevor, B.SC.
SESHAN, Kadayam Gopalier, B.SC.(ENG.)
SILVER, Max Joseph, B.SC.
SNOW, John Brian, M.A.
SQUIRE, Phillip Henry
STEEL, Richard Crawford, M.A.
THOMPSON, Bernard, B.SC.(ENG.)
TURNER, George Edward
VAHI, Pyare Lall
WALSH, Norman
WEBSTER, Ronald Bayliss, B.SC.(ENG.)
WESTERN, Brian Edward, B.SC.
WESTWOOD, Dennis William
WHITE, Douglas Buteux
WILCOCK, Geoffrey Marshall, B.SC.
WINIARSKI, Henry Marian, B.SC.(ENG.)
WINTER, William Edgar
WORDLEY, John
YEO, Mervyn James, B.SC.

Forthcoming Events

September 1957

5–9 *Thursday–Monday* Supply Section Visit to Belgium

18–22 *Wednesday–Sunday* Radio and Telecommunication Section Visit to the Netherlands

October 1957

3 *Thursday* Opening Meeting of the 1957–58 Session (Presidential Address by Mr. T. E. Goldup, C.B.E.)

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 25TH JUNE 1957

	No. of Contributors	£	s.	d.
£1 000 and over	6	6000	0	0
£100 to <£1 000	30	6586	3	0
£5 to <£100	819	8754	3	3
£2 to <£5	2012	5496	9	8
Under £2	21 860	11 347	1	0
		£38 183	16	11

HONOURS AND DISTINCTIONS CONFERRED ON MEMBERS

THE QUEEN'S BIRTHDAY LIST

The names of the following members of The Institution were included in the list of Birthday Honours and Distinctions conferred by Her Majesty:

KNIGHT COMMANDER OF THE ORDER OF THE BRITISH EMPIRE

Harris, Brig. L. H., C.B.E., T.D., M.SC. (*Member*).
Hart, Air Marshal R. G., C.B., C.B.E., M.C., R.A.F. (*Member*).

COMPANION OF THE BATH

Monks, Air Comm. A. T., R.A.F. (*Associate Member*).

COMMANDER OF THE ORDER OF THE BRITISH EMPIRE

Elliott, Col. N. R., O.B.E., M.A., R.E., J.P. (*Member*).
Fennessy, E., O.B.E., B.SC. (*Member*).
Grimmitt, H. W. (*Member*).
Pearce, J. G., O.B.E., DR.ING., M.SC. (*Member*).

OFFICER OF THE ORDER OF THE BRITISH EMPIRE

Ascough, H. L. N. (*Associate Member*).
Scarborough, W. H. (*Associate Member*).
Story, A. L., M.SC.(ENG.) (*Associate Member*).
Weston, G., B.SC.(ENG.) (*Member*).

MEMBER OF THE ORDER OF THE BRITISH EMPIRE

Mann, R. G. (*Associate Member*).
Murray, U. F. (*Associate*).

ELECTION OF COUNCIL FOR THE YEAR 1957–58

The following were nominated for the vacancies which will occur in the offices of President, Vice-Presidents, Honorary Treasurer and Ordinary Members of Council on the 30th September next:

President (*a*) T. E. GOLDUP, C.B.E.

Vice-Presidents (two vacancies)

(*a*) WILLIS JACKSON, D.SC., D.PHIL., DR.SC.TECH., F.R.S.
(*a*) C. T. MELLING, C.B.E., M.SC. TECH.

Honorary Treasurer (*a*) THE RT. HON. THE VISCOUNT FALMOUTH

Ordinary Members of Council

Members (five vacancies)

(*a*) J. S. FORREST, D.SC., M.A.
(*a*) F. C. MCLEAN, C.B.E., B.SC.
(*a*) B. L. METCALF, B.SC.(ENG.)
(*a*) J. R. MORTLOCK, PH.D., B.SC. (ENG.)
(*b*) J. H. R. NIXON
(*a*) C. E. STRONG, O.B.E., B.A., B.A.I.

Associate Members (one vacancy)

(*a*) J. B. HIGHAM, PH.D., B.SC.

Associates (one vacancy)

(*a*) R. H. PHILLIPS, T.D.

(*a*) Nominated by the Council.
(*b*) Nominated by W. Alexander, M.SC.(ENG.), PH.D., C. A. Brearley, B.SC.(ENG.), P. Evans, R. A. Grierson, J. Vaughan Harries, D. E. Lambert, B.SC.(ENG.), D. McLeod, B.SC.(ENG.), J. H. Mitchell, PH.D., B.SC., R. A. Park and Professor J. E. Parton, PH.D., B.SC.

A ballot has been held and the result has been reported by the scrutineers appointed at the Ordinary Meetings held on the 25th April and the 23rd May 1957.

The constitution of the Council for next session will accordingly be as follows:

President T. E. GOLDUP, C.B.E.

The Past-Presidents

Vice-Presidents

S. E. GOODALL, M.SC.(ENG.)
WILLIS JACKSON, D.SC., D.PHIL., DR.SC.TECH., F.R.S.
G. S. C. LUCAS, O.B.E.
SIR HAMISH D. MACLAREN, K.B.E., C.B., D.F.C., LL.D., B.SC.
C. T. MELLING, C.B.E., M.SC.TECH.

Honorary Treasurer THE RT. HON. THE VISCOUNT FALMOUTH

Ordinary Members of Council

Members

PROFESSOR H. E. M. BARLOW, PH.D., B.SC.(ENG.)
J. A. BROUGHALL, B.SC.(ENG.)
C. M. COCK
B. DONKIN, B.A.
J. S. FORREST, D.SC., M.A.
PROFESSOR J. GREIG, M.SC., PH.D.
F. C. MCLEAN, C.B.E., B.SC.
B. L. METCALF, B.SC.(ENG.)
J. R. MORTLOCK, PH.D., B.SC.(ENG.)
H. H. MULLENS, B.SC.
A. H. MUMFORD, O.B.E., B.SC.(ENG.)
D. P. SAYERS, B.SC.
C. E. STRONG, O.B.E., B.A., B.A.I.
H. WATSON-JONES, M.ENG.
H. WEST, M.SC.

Associate Members

E. M. HICKIN
J. B. HIGHAM, PH.D., B.SC.
D. MCDONALD, B.SC.
D. B. WELBOURN, M.A.

Companion

G. L. WATES, J.P.

Associate

R. H. PHILLIPS, T.D.

Chairmen and Past-Chairmen of Sections

*H. J. GIBSON, B.SC. (UTILIZATION)
J. VAUGHAN HARRIES (UTILIZATION)
J. S. MCPETRIE, PH.D., D.SC. (RADIO AND TELECOMMUNICATION)
H. S. PETCH, B.SC.(ENG.) (MEASUREMENT AND CONTROL)
*P. J. RYLE, B.SC.(ENG.) (SUPPLY)
PROFESSOR M. G. SAY, M.SC., PH.D. (SUPPLY)
*D. TAYLOR, M.SC., PH.D. (MEASUREMENT AND CONTROL)
*R. C. G. WILLIAMS, PH.D., B.SC. (ENG.) (RADIO AND TELECOMMUNICATION)

Chairmen and Past-Chairmen of Local Centres

*PROFESSOR F. M. BRUCE, M.SC., PH.D. (SCOTTISH)
*J. CHRISTIE (NORTH-EASTERN)
A. J. COVENEY (NORTH MIDLAND)
*T. E. DANIEL, M.ENG. (NORTH-WESTERN)
*W. K. FLEMING (NORTH MIDLAND)
*C. J. O. GARRARD, M.SC. (SOUTH MIDLAND)
*H. L. HASLEGRAVE, M.A., PH.D., M.SC.(ENG.) (EAST MIDLAND)
T. MAKIN (MERSEY AND NORTH WALES)
*D. S. PARRY (NORTHERN IRELAND)

* Past-Chairman.

Chairmen and Past-Chairmen of Local Centres—(*contd.*)

F. R. PERRY, M.SC.TECH. (NORTH-WESTERN)
J. D. PIERCE (EAST MIDLAND)
*PROFESSOR G. H. RAWCLIFFE, M.A., D.SC. (WESTERN)
*H. ROBSON, B.SC. (SOUTHERN)
L. G. A. SIMS, D.SC., PH.D. (SOUTHERN)
C. M. STOUPE, B.SC. (NORTHERN IRELAND)
*P. D'E. STOWELL, B.SC.(ENG.) (MERSEY AND NORTH WALES)
E. O. TAYLOR, B.SC. (SCOTTISH)
L. L. TOLLEY, B.SC.(ENG.) (SOUTH MIDLAND)
T. W. WILCOX (NORTH-EASTERN)
J. F. WRIGHT (WESTERN)

* Past-Chairman

NOMINATIONS

GOVERNING BODY OF THE BRUNEL COLLEGE OF TECHNOLOGY

The Council have nominated Mr. D. P. Sayers, B.SC., MEMBER, to serve as their representative on the above Governing Body.

CITY AND GUILDS OF LONDON INSTITUTE EXPLORATORY COMMITTEE ON EXAMINATIONS IN ENGINEERING DRAWING

The Council have nominated Professor M. W. Humphrey Davies, M.SC., MEMBER, to serve as their representative on the above Committee.

COMMUNICATIONS FROM OVERSEA MEMBERS

Oversea members are specially invited to submit, for publication in the *Proceedings*, written communications on papers read before The Institution or published in the *Proceedings* without being read. The contributor's country of residence will be indicated. Brief articles, items of news and photographs intended for the *Journal* will also be most welcome.

Copies of all papers read before The Institution are sent to each Oversea Representative of the Council for distribution to members likely to be in a position to submit communications.

MEMBERS TRAVELLING TO AND FROM THE UNITED KINGDOM

Members visiting or taking up residence in the areas of any of the Oversea Branches, Oversea Committees or Joint Oversea Groups, which are listed on pp. 449 and 450, are invited to apply to the Secretary of The Institution for a letter of introduction to the appropriate Honorary Secretary.

The Secretary will be obliged if members coming home from oversea will inform him of their addresses in this country, even if they do not desire a change of address to be recorded in the Institution register. This will enable him to advise such members of the various meetings, etc., of The Institution and its Local Centres, and, when occasion arises, to put them in touch with other members.

The Secretary will be pleased if those members from oversea who are able to visit the Institution premises will call upon him.

BINDING OF B.N.E.C. JOURNAL

Binding facilities for Vol. 1 (1956) of the *Journal of the British Nuclear Energy Conference*, comprising January, July, and October issues, are available at the following prices, which include postage:

Binding case only, 12s. 6d. net.
Case *and* binding, 25s. 0d. net.

Subscribers should send orders for binding cases, or their copies of the B.N.E.C. *Journal* and index (enclosing the appropriate remittance) direct to the B.N.E.C. printers, William Clowes and Sons, Ltd., Publishing Department, Little New Street, London, E.C.4.

THE INSTITUTE OF RADIO ENGINEERS

NEW PROFESSIONAL GROUP ON ENGINEERING WRITING AND SPEECH

The Institute of Radio Engineers has established a new Professional Group on Engineering Writing and Speech. This Group, the twenty-sixth within the Institute, has as its aim 'the study, development, improvement and promotion of the techniques for preparing, organizing for use, processing, editing, collecting, conserving, and disseminating any form of information in the electronics and related fields by and to individuals and groups by means of direct or indirect methods of communication'.

This work will cover the development and publicizing of standards for writing, editing, illustrating and oral delivery of engineering information and the improvement of electrical engineers' writing and speaking. The Institute believes that the Group will attract not only engineers whose work is primarily concerned with the presentation of technical information, but also many other engineers who wish to use the services offered by the Group.

The Institute is planning to hold in New York a Group Symposium on engineering writing and speech in the early autumn of this year. Further information about the Group and details of membership may be obtained from the Secretary, The Institute of Radio Engineers, 1 East 79 Street, New York 21, N.Y., U.S.A.

TRANSACTIONS OF THE PROFESSIONAL GROUPS

Members who subscribe to the complete *Transactions* of the Professional Groups of the Institute of Radio Engineers are asked to note that the annual subscription rate has been increased, as from July 1957, from $75 (£27) to $100 (£35 16*s*.).

THE TIMES FOR TWOPENCE

For many years full-time students have been allowed a rebate of one penny on every copy of *The Times*, and recently this concession was extended to cover the six months after they had finished their courses. The publishers have now decided to increase the rebate to twopence. Students of The Institution who wish to avail themselves of the concession should obtain a registration form from the Subscription Manager, *The Times*, Printing House Square, London, E.C.4. They may then buy *The Times* from a newsagent at the ordinary price, and, from time to time, send their receipted bills to the Subscription Manager, who will refund half the cost of the copies purchased.

CONGRESS ON ELECTRICITY IN MINING AND METALLURGY

NANCY: 25TH–28TH SEPTEMBER 1957

The Société Française des Électriciens have organized a conference on the applications of electricity to mining and

metallurgy and on the utilization of nuclear power, to take place at Nancy from the 25th to 28th September 1957. The programme includes visits to a metallurgical works, a hydro-electric station and a coalfield. The fees for the conference are 1500 francs for members of the society and 3000 francs for non-members. Participants will receive preprints of the papers on electricity in mining and metallurgy, and, after the congress, reprints of the discussions on the utilization of nuclear power. Further details may be obtained from the Secretary, Société Française des Électriciens, 8–14 Avenue Pierre-Larousse, Malakoff, Seine, France.

NEWS *from Abroad*

BRISBANE

QUEENSLAND OVERSEA COMMITTEE

Design and Computers

When Mr. Duncan McDonald (a member of Council) was making a short visit to Brisbane, he delivered a lecture on the 29th March entitled *Power Transformers for High-Voltage Transmission, with special reference to Design Trends.*

The meeting was opened by Mr. J. S. Just, who introduced Mr. McDonald to the audience. Invitations had been extended to The Institution of Engineers, Australia, and to the electricity authorities in Brisbane. A very representative audience was present, including a number of senior students from the Faculty of Engineering, Queensland University.

In his lecture Mr. McDonald developed several formulae which indicated the relationship between the main variables in transformer design. In particular, he laid stress on the importance of providing the designer with the loss-ratio relationship for a particular transformer application, so that the most economical design could be produced. He spoke of the effect on design of the ever-increasing transmission voltages, and showed how the necessary higher impulse levels have influenced coil arrangement.

From design features Mr. McDonald passed to the application of the computer to transformer design. He described the very thorough analysis of the principles of design that must be carried out when endeavouring to establish a procedure that could be dealt with by the computer. These principles, which are used quite unconsciously by the human designer, must be presented in a logical sequence for assimilation by the much more mechanical approach of the computer. Mr. McDonald explained that it might take many months to work out a procedure for dealing with an application such as transformer design, but that having established the procedure individual problems could be prepared for the computer in a few minutes, and the result obtained within seconds of presentation. Not only was it possible to produce a transformer design by use of the computer, but also, within an extremely short space of time, to prepare parallel data for graphic presentation of certain fundamental transformer characteristics. Similar data could only be produced by the human designer after weeks of detailed calculation.

The lecture was most informative and interesting. After a period of discussion, when questions were answered by Mr. McDonald, a vote of thanks was proposed by Mr. J. E. Morwood, and carried with acclamation. W. I. G.

ABSTRACT FANTASY

Not long ago the Editor of *Science Abstracts* was surprised to receive from one of his panel of electrical engineering abstractors two brief and differing versions of an American article on communication equipment for use in operating theatres. The abstractor in question, Mr. H. G. M. Spratt, had not been completely happy about his first version, which read somewhat solidly as follows:

An intercom system has been brought about by the introduction into the operating theatre of electronic equipment such as electro-encephalographs, stimulators and the like. It is particularly valuable in surgical treatment of epilepsy where conversations with the patient must be heard by the e.e.g. team. The system involves headsets and foot switches and microphones suitable for persons wearing masks. There is also a tape recorder for playing music to the patient. The equipment must not jeopardize sterility or introduce interference and must be safe to use in an explosive atmosphere.

Feeling that he had somehow missed the spirit of the original, Mr. Spratt re-read the article both along and between the lines. Again he performed a process of extraction and distillation to produce a second version. This time his resulting matter was really liquid, and indeed gently effervescent:

The installation of a telecommunication system, without petty restrictions as regards cost or simplicity and based broadly on the lines of the usual coast-to-coast network, is considered essential for the modern operating theatre fitted with electro-encephalographs; stimulators; simulators; dissimulators; lie detectors; and artificial kidneys, gizzards and my foot. The article describes—with considerable restraint—the conditions under which an operation on the brain for epilepsy is carried out, where an e.e.g. is employed and local anaesthetics are administered to enable the patient to conduct his normal business the whole time. All the surgeons, nurses, patients and stage hands, etc., have headsets and microphones with trailing leads, and when the producer calls 'over', you never saw such a tangle in all your life. The operating staff wear masks for the sole purpose of preventing the sordid habit of spitting into the microphone. The patient is encouraged—within limits—to use his microphone channel. When special tone filters, at present under development, for blocking the harsher and more fricative monosyllables have been included in his channel, he can say just what he likes. The introduction of a tape recorder has proved to be a marked improvement, on the grounds of hygiene, over the symphony orchestra previously employed. The e.e.g. team are skilled clog dancers and are expected to tap out the α- and R-rhythms as they are recorded on the chart. A live audience is always present but separated from the operating room by glass partitions to prevent 'cutting in'. The head surgeon is provided with a 3-position foot switch to enable him to call: (*a*) the team to order; (*b*) the local fire brigade; or (*c*) for drinks all round. Trepanning is carried out by means of an ultrasonic drill provided with automatic feedback to maintain the travel of the tool to within ± 3 in. The theatre staff use mine detectors to detect the presence of such tools as tyre levers left in the skull or tramp metal in the potting compound poured in to replace excised tissue. Two new developments in this field are under consideration: (*a*) to perform the operation on ice, with all the operators trained skaters; and (*b*) to provide a telecontrol system so that the master surgeon can simultaneously perform the same operation—or perhaps different ones—on a number of patients in separate hospitals.

We must report that the Editor of *Science Abstracts* has unfortunately—if not unwisely—chosen Mr. Spratt's first version for publication. But readers of the *Journal* will surely appreciate this chance to sample a recent number of *Science Abstracts* as it might have been.

LONDON REPORT

MEASUREMENT AND CONTROL SECTION

Liquidation of Field Problems

Although somewhat formidably entitled *A Deep Electrolytic Tank for the Solution of 2- and 3-Dimensional Field Problems in Engineering*, the paper by E. R. Hartill, J. G. McQueen and P. N. Robson was in fact a fascinating account of the design and use of 'a washtub with a college education' to form part of the computing service of a large engineering organization. The paper was read at a Measurement and Control Section meeting on the 9th April, to an interested audience of about sixty. It is reviewed on p. 420.

In their opening remarks, the authors briefly outlined the analogous equations which govern the use of the tank in the solution of problems involving electric, magnetic or thermal fields. They described the elementary requirements of such tanks and the mechanical construction of their own version. They also described the electronic equipment which is used to generate the short current pulses which provide the conduction field, and also to measure the probe potential, or potential gradient. An interesting novel feature was the use of silicone varnish applied close to the probe ends to reduce meniscus effects.

Tests to determine possible accuracy were outlined, and the authors said that in their view the repeatable accuracy lay between $\pm 1\%$ and $\pm 2\%$.

After this, the authors described a number of practical uses to which the tank had been put. These included an investigation of the value of high-permittivity insulators in securing uniform voltage distribution over an insulator string, a study of trajectories in a proton linear accelerator, investigation of the flow of slip frequency conduction current in the bars and rings of the rotor of a squirrel-cage induction motor, studies of field distribution in a high-voltage layer-type transformer winding, the determination of the reactance of transformer windings, and a study of the field in a switchgear plug and spout bushing. The tank had also been used for thermal studies and to determine neutron-flux distribution in nuclear reactors.

In the brief but lively discussion which followed, the experts in the subject expressed appreciation of the authors' approach. Questions were raised about the appropriate conductivity of the water used, and the maintenance of its cleanlinesss, and a reference to detergents revived thoughts of washtub origins. Comparisons were made with other systems of field plotting, such as resistance networks, rubber sheet models, and relaxation methods.

In their replies the authors satisfactorily answered the direct questions. It appeared that for one study they used their tank linked with other computing apparatus, and, estimating the value of the tank at around £1000, considered it to be the cheapest part of the whole equipment. They thought the tank superior to alternative methods on the grounds of either time or accuracy, and they also made the point that in their electron-trajectory studies they were working with time-varying fields.

In thanking the authors at the close of the meeting, the Chairman, Dr. Denis Taylor, remarked on the obvious versatility of the electrolytic tank, and was clearly impressed by its relatively low cost.

H. S. P.

UTILIZATION SECTION

That the subjects under discussion at the meeting of the Section on the 11th April were of exceptional interest was clearly demonstrated by the large number of members present, the lecture theatre being completely filled. The Section was also honoured by the presence of the President.

Two papers were read. The first, entitled *Development of Transportable Thermal Storage Space Heaters*, by E. Bates, described the experiments leading up to the design and production in this country of automatically controlled transportable units for use in commercial and industrial premises. The paper is reviewed on p. 422. The author stated that the ideal characteristics of the heat-storage material are high specific heat, low thermal conductivity and low specific weight. He also expressed the view that unless an attempt is made to divert the day-time heating demand, it might conceivably grow to unmanageable proportions, because, not only is electric heating in accordance with present-day desires and conditions, but the relative cost to the user has never been so favourable to electricity. He also stressed the point that thermal heaters are not necessarily suitable for every situation, their application being considered economic only in rooms in daily use. Due attention must also be paid to the type of building to be heated.

The second paper was called *Electrical Floor Warming*, by J. W. Moule and W. M. Stevenson, who pointed out that the desirable features of space heating are the transmission of warmth to the human body, mostly by radiation from uniformly warm surroundings, and the minimizing of air movements. Two types of installation were described. In one, circular or D-shaped metal housings are incorporated in a concrete floor during building, the heating cables being drawn in later, while in the other type, the heating cables are buried solidly in the concrete floor. The latter system is cheaper to install, but the concrete screed must be broken to gain access in the event of a fault. A review appears on p. 423.

In opening the discussion, Mr. J. I. Bernard said that the papers showed clearly that thermal-storage heating was now both practicable and controllable, and that it was also possible to obtain good comfort. In addition, he pointed out that it was not easy to convince builders of the necessity to ensure a reasonable degree of thermal insulation in buildings.

A large number of other speakers took part in the discussion, representing a considerable variety of interests, including heating and ventilation engineers, some of whom appeared to be rather sceptical of the results achieved by these new developments. The withdrawable and the solidly-buried types of floor heating each had its protagonists.

Among other points raised were the importance of proper design of installations, the necessity of avoiding the sale of block storage heaters simply from catalogues, the lack of appreciation that such heaters had a considerable inherent overload capacity that could be used to meet cold spells, the degree of fire risk associated with these heaters, and the poor siting of thermostats as a cause of unsatisfactory heating.

It was also emphasized that every effort should be made to obtain an alteration in the purchase tax on the domestic use of block heaters, since this is the only method of providing storage heating in existing houses.

R. H. R.

NEWS *from the Centres*

BURTON AND STAFFORD

NORTH STAFFORDSHIRE SUB-CENTRE

Itinerary Achievement

A third successful District Meeting was held at Burton-upon-Trent on the 20th February, when the convener, Mr. F. Overstall, invited Mr. G. F. Peirson to read the paper *Automatic Circuit Reclosers*, of which he is co-author with Messrs. A. H. Pollard and N. Care. The paper was illustrated by slides and a film and proved of great interest, particularly to those engineers present who were concerned with supply to rural areas by overhead lines. A lively discussion followed in which twelve of the thirty members and guests took part. The reduced attendance, compared with previous years, was undoubtedly due to petrol rationing, which also caused considerable inconvenience to the authors, who had to travel from Carlisle by train instead of by car. The numerous changes, accompanied by the large amount of equipment carried, made the journey very arduous and something of a feat. The enthusiastic support accorded to the vote of thanks, proposed by Mr. A. T. Chadwick, may also be taken as a measure of the value of these local meetings.

With the Graduates and Students

A joint meeting with the Graduate and Student Section was held at Stafford on the 13th March. Mr. H. A. P. Caddell apologized for the unavoidable absence of the Chairmen, Mr. A. T. Chadwick and Mr. A. P. Baines, whose places were taken by himself and Mr. W. G. Lloyd.

Three short papers were read by members of the Graduate and Student Section—*Principles of Circulating Current Protection Schemes* by Mr. J. A. Burley, *Survey of Recent Tidal-Power Developments* by Mr. A. R. Carrie, and *Electrical Drives for High-Speed Rod Mills* by Mr. J. I. Jones. Discussion of the three papers was opened by Mr. C. F. Ferguson, Mr. A. Wheeler and Mr. R. Larkinson respectively, and many other speakers took part. Mr. J. E. Boul proposed a vote of thanks to all three authors and said the papers truly fulfilled the basic purposes of disseminating knowledge and stimulating discussion, and they exhibited diligent application in their preparation. He complimented the authors on the excellent presentation of their subjects and on their replies to the discussion.

Students' Exhibition

On the 16th March the Graduate and Student Section held a Conversazione and Exhibition at Stafford Technical College by kind permission of the Principal, Mr. A. Torkington. Models and appliances were loaned by several manufacturing companies and Government organizations, while Student members in the college, in conjunction with the staff, arranged a series of working models in the hall and in the Lenz electrical laboratories. These included a 150kV impulse generator, photo-electric counters, synchronizing equipment, stroboscopes and demonstration of travelling waves, vacuum-tube lighting techniques, mine winding equipment and rectifier control of motor speed, as well as attractive demonstrations of short-circuited turns in alternating magnetic fields. There was also a continuous film show with an hour's programme including *The Inquiring Mind*.

Tea was served by the Committee members' wives and friends, who had also made the cakes and refreshments. A total of 2002 was registered by an electronic counter, but it is estimated that the actual attendance at this most interesting and successful function was about four hundred. It is suspected that the activities of some of the younger visitors were responsible for the difference in totals!

L. G.

EDINBURGH AND GLASGOW

SCOTTISH CENTRE

Election, Corrosion, Reproduction . . .

The Annual General Meetings of the South-East and South-West Scotland Sub-Centres were held in Edinburgh and Glasgow on the 30th April and the 1st May respectively. In Edinburgh the formal business, which included the election of Mr. J. Mendelson as Chairman of the Sub-Centre for 1957–58, was followed by the customary short papers by a member of the Graduate and Student Section and by a senior member.

Mr. C. G. Campbell, Graduate, delayed his impending departure for Uganda to deliver a paper on *Corrosion of Overhead-Line Equipment*, which he had previously presented to the Graduate and Student Section. Mr. Campbell described and illustrated by slides and samples various corrosion difficulties arising with different forms of overhead-line conductors, and he very ably answered the questions subsequently put to him.

Mr. G. I. Thomas, Honorary Secretary of the Sub-Centre, gave the second paper on *Stereophonic Sound*, with demonstrations kindly arranged by Mr. Bryce Lane. Mr. Thomas explained clearly the principles of stereophonic sound, but perhaps the real enjoyment of the lecture came from hearing excellent reproductions of excerpts from various operas.

. . . and Radiolocation

At the meeting of the South-West Scotland Sub-Centre, Dr. A. J. Small was elected Chairman for the next session. Next on the programme was a paper by Miss Sheila Weir on *The Early Development of Radar*. This paper was originally read as the Chairman's Address to the South-East Scotland Students Section in 1955 and subsequently at the Annual General Meeting of the South-East Scotland Sub-Centre. News of the excellence of the paper had evidently spread to the west, and it was thoroughly enjoyed by the Glasgow audience. Mr. E. B. Brash opened a most interesting discussion with some of his own personal experiences in this field.

E. O. T.

LIVERPOOL

MERSEY AND NORTH WALES CENTRE

Liverpudlian Home Life

The thirty-fifth Annual General Meeting was held at the Royal Institution, Liverpool, on the 1st April, when Mr. T. Makin was elected Chairman for the 1957–58 Session, and the constitution of the new Committee was announced.

The Local Centre Graduate and Student Prize was presented

to Mr. K. S. Stather for his paper *Developments in the Cooling of Turbo-Alternator Windings*.

At the ordinary meeting which followed, the paper by E. L. E. Wheatcroft and H. H. C. Barton on *The Potentialities of Railway Electrification at the Standard Frequency* was presented, in the unavoidable absence of the authors, by Mr. F. C. E. Smith, who replied in detail to a somewhat critical discussion.

Additional District Meetings have been held—one at Warrington, where an attendance of forty-two provided a very good discussion after the reading by Dr. G. F. Tagg of *The Measurement of Earth-Loop Resistance*, and the other in Wigan, where the Chairman repeated his Inaugural Address to an audience of sixty.

The Annual Dinner-Dance was enjoyed by 275 members and ladies, and we were delighted to have present several of our neighbours from the North-Western Centre. Prizes generously provided by members enabled the organizers to realize over £50 for the Benevolent Fund. It was interesting to reflect as the winners made their choice from the prizes on view—a gentleman selecting nylon stockings, and a lady preferring a box of cigars—that the standard of domestic felicity and co-operation must be quite high.

Golf at Southport

The Annual Golf Competition was held on the 28th May on the championship course of the Southport and Ainsdale Golf Club, where 75 members and friends revived ancient feuds with Colonel Bogey and each other, and it was particularly gratifying to welcome members of the North Eastern and North Western Centres.

The arrangements were handled by Mr. F. J. Brown, with assistance from Mr. G. L. Simpson. As Mr. R. M. Gravett had been very much occupied in previous years with organizing duties, it was very appropriate that he should take the singles honour by winning the G. P. Dennis Challenge Cup. The Centre was officially represented by Mr. T. Makin, Vice-Chairman, and the prizes were presented by the Club Captain, Mr. A. F. Cullen. The resulting contribution to the Benevolent Fund was over £50.

Obituary

We record with regret the death of Mr. Thomas Smith on the 7th February at the age of eighty. He became an Associate Member in 1913, and in 1923 he and a partner constructed a small hydro-electric scheme to supply electricity to the village of Llanrhaiadr-ym-Mochnant. For thirty-four years the single turbine met the requirements of the village, and was withdrawn only when the Electricity Board network became available in February of this year. E. W. A.

NORTH COUNTRY

NORTH-EASTERN CENTRE

The formal meetings of the 1956–57 Session have ended, and it is with satisfaction that we look back on a year of progress and consolidation in many of our new ventures. District Meetings have continued to be well supported in both Carlisle and Workington; a Graduate and Student Sub-Section is now in being on Tees-Side, replacing the District Meetings which were previously organized there; and our first experience of technical visits for many years has proved highly successful.

Two technical visits have been held this year. The first, in February, was to the new oil-seal works of George Angus and Co. at Wallsend, where a party of over thirty members spent a most interesting evening seeing round this up-to-date plant, which makes a highly specialized group of products. Then, in April, about seventy members visited the high-power research department of A. Reyrolle and Co. at Hebburn. After an introductory talk and film, the party toured the short-circuit testing stations, seeing both the original plant, which dates from 1929, and the new plant commissioned in 1954. The support for these visits leaves little doubt that similar activities will be organized in future sessions.

Apart from the regular meetings of the Centre, the second half of the 1956–57 Session has contained many items of interest. An informal meeting was held in March, at which two very interesting and instructive talks were given on subjects outside the scope of our ordinary meetings; one, by Commander J. C. Turnbull, described *The Work of the Royal Naval Electrical Branch at Sea*, and the other, by Mr. G. M. Sisson, told of recent developments in astronomical telescopes. Although not so well attended as in the previous year, this informal meeting remains a popular function with

A group at the Dinner-Dance of the Mersey and North Wales Centre

Standing, from left to right: Messrs. D. H. Kendon, T. Coates, P. d'E. Stowell, T. E. Daniel and M. M. Parker, Mrs. Parker and Mr. G. F. Pierson.
Seated, from left to right: Mrs. Heyes, Mrs. Stowell, Mrs. Pierson, Mrs. Kendon, Mrs. Coates, Mr. F. R. Griffin and Mrs. D. Yates.

many members of the Centre, and has now become a regular feature of each session's programme.

We were invited by the North Eastern Branch of The Institution of Mechanical Engineers to attend their meeting on the 29th April, at which Sir Claude Gibb repeated his Thomas Hawksley Lecture, *Some Engineering Problems in the Industrial Development of Nuclear Power*. We are indebted to our friends of The Institution of Mechanical Engineers for giving us this opportunity of hearing the lecture.

Dr. T. E. Allibone gave his Faraday Lecture *Nuclear Energy in the Service of Man* in the Newcastle City Hall on the 2nd April. The demand for tickets far exceeded the capacity of the hall, but over 2 000 people who were lucky enough to get seats enjoyed a lecture which well maintained the high standard which we have come to expect.

The President, Sir Gordon Radley, attended our Annual Dinner and Dance in the Old Assembly Rooms, Newcastle, on the 22nd March, and Sir Hamish MacLaren paid a Vice-Presidential visit to the Centre when he attended the Annual General Meeting at the Royal Station Hotel on the 8th April. We were honoured to have these senior officers of The Institution among us, and appreciate having personal contact with them at such functions. J. C. A.

EAST ANGLIA

EAST ANGLIAN SUB-CENTRE

The last ordinary meeting of the session was held in Norwich on the 28th March 1957. Mr. C. L. C. Allan, Chief Engineer of the North of Scotland Hydro-Electric Board, made the long journey from Edinburgh to Norwich via London to talk on *Highland Water Power*, and the meeting was most successful.

Five meetings for Graduates and Students have been held during the session, but the attendances have been disappointing. Strangely enough the younger members attended ordinary meetings in greater numbers than the specially arranged Graduate and Student meetings. It was suggested by an enthusiastic Graduate that a Graduate and Student Section should be formed in East Anglia, but in view of the poor support at Graduate and Student meetings, it has been decided to defer formation and to reconsider the suggestion at the end of next session.

The Committee report with deep regret the death of Mr. F. L. Best*. He was a founder Committee Member of the Sub-Centre and an enthusiastic supporter of Institution activities.

For the last event of the session a Summer Visit to Norwich has been arranged for Friday and Saturday, 20th and 21st September 1957. Members and their ladies will visit factories in Norwich on the Friday afternoon and there will be a dinner party in the evening. On the Saturday there will be a tour of the Norfolk Broads followed by a visit to the newly constructed South Denes generating station near Great Yarmouth. Details have been circulated but those members who have mislaid their notices may obtain further information from the Honorary Secretary.

The next Annual Dinner-Dance will be held in Cambridge on the 3rd January 1958.

Finally, congratulations are offered to one of our Corporate Members, Mr. C. T. Melling, on his election as a Vice-President. N. H.

* An obituary notice appears on p. 426.

PORTSMOUTH

SOUTHERN CENTRE
GRADUATE AND STUDENT SECTION

Presentation to Past-Chairmen

The Graduate and Student Section of the Southern Centre recently decided to present inscribed copies of *The History of The Institution* to the three most immediate Past-Chairmen. At the Section's request the Chairman of the Centre, Mr. H. Robson, made the presentations to Messrs. A. Teague, K. Dibb and H. New at a joint meeting held at Portsmouth on the 6th March. E. A. L.

History without tears

From left to right: Mr. J. Williamson (Chairman, Graduate and Student Committee, Southern Centre), Mr. H. Robson and Mr. H. New, Mr. A. Teague and Mr. K. Dibb.

RUGBY

RUGBY SUB-CENTRE

Look Back on Success

During this session, under the Chairmanship of Mr. J. H. Cansdale, the Rugby Sub-Centre has continued to flourish. The average attendance at the meetings has been of the order of seventy and even the lowest attendance was forty; these figures reflect a general interest in all the papers selected by the Committee for reading in Rugby.

At the opening meeting Mr. J. H. Cansdale gave his Chairman's Address *Power for Transport*, which described the progress which had been made in electric traction. He also dealt with the latest proposals for the electrification of British Railways. Sir Hamish MacLaren, a Vice-President of The Institution, attended the meeting and presented premiums for papers won by members of the Sub-Centre.

Probably the paper which created the most interest was that by Messrs. E. W. Hayes and H. Page, presented in Rugby by Mr. Page, on *The B.B.C. Sound Broadcasting Service on Very High Frequencies*. Through the co-operation of local firms and radio dealers we were able to install a suitable aerial system at the Technical College so that Mr.

Page was able to demonstrate the results obtainable in the Rugby district from this latest form of broadcasting. We were also pleased to welcome Professor F. Brailsford who gave a lecture on ferrites, and Dr. R. L. Grimsdale who gave a lecture on digital computers. The latter occasion was a joint meeting with the Graduate and Student Section; it was gratifying to note that the students were not in any way reticent and took an active part in the discussion which followed the reading of the paper.

Mr. G. S. C. Lucas, a Vice-President of The Institution and a local member, was recently one of a delegation who visited Russia to study technological education in that country. He lectured to the Sub-Centre on some of his impressions and illustrated his talk by colour photographs which he had taken during the visit. Once again a good discussion followed.

Two District Meetings have been held, both of which were very well attended. The first was at Banbury, where Mr. S. S. Carlisle presented a lecture based on his paper entitled *Instrumentation in the Iron and Steel Industry*. The second was at the Plough Hotel, Northampton, where Mr. J. F. Coales, of Cambridge University, gave a lecture on *The History of Automation*. The discussion at both meetings was up to the usual high standard, and the less formal atmosphere created by the District Meetings does much to add to their enjoyment. Our thanks are due to Mr. V. H. Fearon who was responsible for the Banbury meeting, and to Messrs. E. A. Cross and J. Metcalfe who made the arrangements at Northampton.

The Faraday Lecture, given in the Temple Speech Room on the 16th January 1957, was an outstanding success. In fact the crush was such that some concern was caused to the Headmaster of Rugby School and to the local Secretary when some of the audience, in order to obtain a better vantage-point for seeing the proceedings, clambered on to the two grand pianos stored in the Speech Room. Fortunately no damage was done. Some members of the public to whom tickets had been issued could not unfortunately gain admission; it was necessary for an apology to be printed in the local Press to explain that the unprecedented attendance had upset the plans which were based on the experience of many previous years.

The main social event during the session was the Engineers' Ball held at Chesford Grange on the 22nd March. This was organized jointly by the Rugby Engineering Society and the Sub-Centre. Mr. and Mrs. G. S. C. Lucas were The Institution's guests of honour, and the Rugby Engineering Society invited the Mayor and Mayoress of Rugby and Mr. W. Cooper, Principal of the College of Technology and Arts, and Mrs. Cooper. Approximately 460 people attended the Ball, and reports indicated that it was an enjoyable evening. In future years the Ball will be run by a Committee comprising members of the Rugby Engineering Society, the Rugby Panel of The Institution of Mechanical Engineers and the Sub-Centre. Since it will cease to be the official social gathering of the Sub-Centre, a dinner is being organized during November as the official function.

We should like to record in these pages the excellent relationship that exists between ourselves and our parent, the South Midland Centre; they admonish us little, and when we ask for help, even though this may be financial, they respond willingly.

The Rugby Sub-Centre has completed another successful session, and with Mr. Carfrae as Chairman-Elect we look to the future with confidence. E. S. H.

SWANSEA AND LLANELLY

WEST WALES (SWANSEA) SUB-CENTRE

An ordinary meeting was held on the 8th November 1956, when Mr. E. L. E. Wheatcroft read his and Mr. H. H. C. Barton's paper *The Potentialities of Railway Electrification at the Standard Frequency*. Mr. Wheatcroft was accompanied by Mr. F. C. E. Smith, who replied to the ensuing discussion. Mr. G. Richards, who proposed a vote of thanks to the speakers, put forward a noteworthy plea for electric traction in the Welsh valleys.

At a District Meeting, which was held in Llanelly, on the 19th November 1956 and was convened by Mr. I. G. Evans, Mr. Forbes Jackson, Deputy Chairman of the Wiring Regulations Committee, opened a discussion on the Thirteenth Edition of the Regulations for the Electrical Equipment of Buildings. He outlined the growth of the Regulations since the introduction of the first edition in 1882. That first edition consisted of a mere 3½ pages. He emphasized that the Regulations should be regarded as the minimum requirements to avoid fire and shock. The questions that followed were many and varied, and stressed some of the deeper issues involved in what might appear to be simple techniques. Members were left with the sobering thought that most ring-main plugs are sold with 13 amp fuses in them, and many of them remain like that, no matter what the duty to be performed.

The Faraday Lecture was presented by Dr. T. E. Allibone in the Brangwyn Hall, Swansea, on the 27th November 1956. This event continues to attract the people of the Swansea area and there was a heavy demand for tickets.

The paper entitled *Germanium and Silicon Power Rectifiers*, by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell, was presented by Mr. G. A. Carrick at an ordinary meeting held on the 13th December 1956. Mr. J. Nelsey, who opened the discussion, referred to load-sharing difficulties and possible ultimate failure that could arise from initial mismatching of parallel units. After discussing the relative efficiencies of germanium and selenium rectifier installations, he expressed the view that the great saving in space that the germanium rectifier offered, rather than its efficiency, might make it attractive in the tin-plate industry.

Mr. Carrick replied that mismatching could be overcome by suitably derating the rectifiers.

On the 10th January 1957 Mr. S. S. Carlisle read his paper *The Instrumentation of a 14-inch Experimental Rolling Mill*. The subject was of particular interest, because the author is now a member of the Swansea Sub-Centre, and his subject was closely related to one of the major industries of the district. Some criticism of the method employed for measuring strip tension was levelled at the author, in that results would be distorted by inertia effects. Instrumentation is rapidly becoming a highly specialized field, and as one member aptly put it, 'In the process of passing through the Electronic Age, we have now reached the Instrumentation Era'. R. F. D.

YORKSHIRE

NORTH MIDLAND CENTRE

A joint meeting with the Sheffield Sub-Centre was held at Barnsley Town Hall on the 6th March, when our Centre Chairman, Mr. W. K. Fleming, initially presided over the seventy members and guests. Then, in accordance with

custom, Mr. Fleming, as the host, invited Mr. G. G. Nicholson, Chairman of the Sheffield Sub-Centre, to take the chair for the remainder of the meeting. Mr. Nicholson introduced the speaker, Mr. T. E. Green, and invited him to present his paper entitled *Mine Locomotives*. Mr. Green, a most accomplished speaker, described development of mine locomotives in the past ten years. It became apparent that there is considerable competition between battery and Diesel locomotives, in which the former is gaining considerably. He forecast that future locomotives will be run at speeds three to four times faster than at present. The discussion, which was opened by Mr. E. A. Battye, and continued by ten other speakers, dealt mainly with improved designs of battery locomotives and looked forward to the use of motors of, say, 70 h.p. and to the considerable benefits which could be obtained by the use of rheostatic braking. The author replied most fully to the discussion and all were in accord with the hearty vote of thanks proposed by Mr. A. J. Coveney. Mr. Nicholson also thanked Mr. J. H. J. Richards for the excellent local arrangements which he continues to make for this annual meeting.

Faraday Lecture

On the 25th March, at Leeds Town Hall, we were honoured to have Dr. T. E. Allibone to present the Faraday Lecture to a full house of about 1500 people. Mr. W. K. Fleming, the Chairman, before introducing Dr. Allibone, gave an excellent account of the life and work of Michael Faraday, and spoke of the far-sightedness of The Institution in making possible this series of lectures, for the benefit of the public. The lecture itself, with its wealth of demonstrations, was greatly appreciated by the large audience, particularly as the subject, *Nuclear Energy in the Service of Man*, is so very topical. Dr. Allibone spares nothing in his determination to make this difficult subject understandable to the layman. His enthusiasm is most infectious, and the well-merited applause which greeted him when he closed must have shown him something of our appreciation. A formal vote of thanks was very ably proposed by Mr. Fleming.

Electricity versus the Diesel Engine

Our seventh ordinary meeting was held at York on the 2nd April before a large and appreciative audience when the Chairman, Mr. W. K. Fleming, after welcoming two new Corporate Members, introduced Mr. F. C. E. Smith, who presented the paper entitled *The Potentialities of Railway Electrification at the Standard Frequency*. This paper was written by E. L. E. Wheatcroft and H. H. C. Barton, but, since neither of the authors could attend, Mr. Smith gallantly stepped into the breach. He said that the paper was the result of a number of investigations abroad, in which alternating current had proved the best source of power. From 1906 to 1923, low frequencies of the order of 16⅔c/s had been prevalent, but the new technique of mounting rectifiers on the locomotives, particularly the single-anode ignitron rectifiers, made 50c/s working a much more economical proposition. He explained that high traffic density favours electrification; at about eight million tons per annum per single-track mile, a balance is achieved between the economics of electric and Diesel traction. The discussion, which was opened by Mr. E. A. K. Jarvis and continued by eight other speakers, covered the subject widely. A vote of thanks, ably proposed by Mr. J. F. Cunningham, brought a very interesting evening to a close.

Annual Dinner-Dance

Our Annual Dinner-Dance was held at the Cairn Hydro Hotel, Harrogate, on the 5th April, when members were received by a Vice-President of The Institution, Mr. G. S. C. Lucas, and Mrs. Lucas, and Mr. and Mrs. W. K. Fleming. A record gathering of 350 members and guests enjoyed an excellent meal, and Mr. Lucas, in a short address, said that he brought the greetings not only of The Institution itself but of the South Midland Centre, which was his home centre. Mr. J. R. Rylands, the local Honorary Secretary of the Benevolent and Homes Funds, made an appeal for support for the prize draw in aid of the Funds, and also thanked the many firms and individuals who had sent prizes; the draw which took place later realized a record sum of over £150. Dancing continued until 1 a.m.

A group at the North Midland Centre Annual Dinner-Dance

From left to right: Mr. and Mrs. W. K. Fleming and Mr. and Mrs. G. S. C. Lucas.

UTILIZATION GROUP

The fifth Utilization Group Meeting on the 19th March was a joint meeting with the North Midland Graduate and Student Section. Present on this occasion was the Section Chairman, Mr. H. J. Gibson, who said that in his visits to Utilization Groups throughout the country he had been inspired to find the care taken and the enthusiasm shown at meetings. He felt that nuclear power would alter the pattern of finance, and load-factor considerations must be solved. This was where the Utilization Section would come into its own, in finding new uses for power at night. The paper read at this meeting was called *Power Supply Problems in Coal-Mining* by D. C. Graham, a member of the Graduate and Student Section. This paper was a very able coverage of this most interesting subject, which defined the problems arising in mining and showed the types of electrical equipment which have been developed to meet them. It was unfortunate that insufficient time was left for the discussion. Our thanks were expressed to Mr. Gibson by Mr. A. R. Rumfitt, and to Mr. Graham by the Chairman, Mr. R. Spence. J. L.

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Hon. Asst. Secretary: T. H. SCHOLES, c/o A. Reyrolle & Co. Ltd., 20 St. Paul's Street, Leeds, 1.

North Midland Utilization Group

Chairman: R. SPENCE.

Hon. Secretary: G. AUTON, Yorkshire Switchgear and Engineering Co. Ltd., Meanwood, Leeds, 6.

Sheffield Sub-Centre

Chairman: G. G. NICHOLSON, M.ENG.

Hon. Secretary: J. A. WALKER, 154 Springfield Road, Sheffield, 7.

Hon. Asst. Secretary: G. L. MASON, 36 Totley Brook Road, Sheffield.

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Hon. Asst. Secretary: H. DIGGLE, B.SC.TECH., Transformer Engineering Dept., Metropolitan-Vickers Electrical Co. Ltd., Wythenshawe, Manchester, 23.

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Chairman: F. BEECH.

Hon. Secretary: R. W. FRYER, 2 Rossett Avenue, Timperley, Altrincham, Cheshire.

North-Western Radio and Telecommunication Group

Chairman: G. J. SCOLES, B.SC.(ENG.).

Hon. Secretary: J. WILLIS, B.SC., Lecturer in Electrical Engineering, The College of Technology, Manchester, 1.

North-Western Supply Group

Chairman: C. H. FLURSCHEIM, B.A.

Hon. Secretary: F. W. GEE, B.SC.TECH., Chief Development Engineer, Transformer Dept., Ferranti Ltd., Hollinwood, Lancs.

North-Western Utilization Group

Chairman: G. H. DAVIDSON.

Hon. Secretary: W. F. JARVIS, c/o North Western Electricity Board, No. 1 Sub-Area, Town Hall Ext. (4th Floor), Manchester, 2.

North Lancashire Sub-Centre

Chairman: E. H. SCHOLES.

Hon. Secretary and Treasurer: F. DAY, The North Western Electricity Board, 40/41 Lune Street, Preston.

Hon. Asst. Secretary: J. G. FLOOD, The North Western Electricity Board, 40/41 Lune Street, Preston.

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Chairman: DOUGLAS S. PARRY.

Hon. Secretary: R. L. MARRS, B.SC., 'Chez Moi', Mosside Road, Dunmurry, Co. Antrim.

Hon. Asst. Secretary: W. H. FARMER, Room 49, Telephone House, 1 Cromac Street, Belfast.

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Hon. Asst. Secretary: R. L. STANLEY, c/o Johnson and Phillips, Ltd., 59 Berkeley Street, Glasgow, C.3.

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Hon. Secretary and Treasurer: T. M. MCCAMMONT, North of Scotland Hydro-Electric Board, Milburn Street, Aberdeen.

Hon. Asst. Secretary: H. P. DURRANT, B.SC.(ENG.), c/o Sturrock and Murray Ltd., Victoria Dock, Dundee.

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Hon. Secretary: E. H. COX, Midlands Electricity Board, Mucklow Hill, Halesowen, Birmingham.

Hon. Asst. Secretary: J. C. PYATT, c/o Central Electricity Authority, 53 Wake Green Road, Moseley, Birmingham, 13.

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Chairman: E. E. WARD, PH.D.

Hon. Secretary: K. B. WILSON, B.SC.(ENG.), Department of Electrical Engineering, College of Technology, Gosta Green, Birmingham, 4.

South Midland Supply and Utilization Group

Chairman: T. G. D. WINTLE.

Hon. Secretary: H. C. FOX, George Ellison, Ltd., Perry Barr, Birmingham, 22a.

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Hon. Asst. Secretary: R. W. ROBINSON, 51 Yates Avenue, Newbold Glebe, Rugby.

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Hon. Secretary: H. W. HOUSLEY, 15 Southdown Road, East Cosham, Portsmouth, Hants.

Hon. Asst. Secretaries: A. C. TREMAIN, B.SC.(ENG.), Municipal College, Portsmouth, Hants. C. G. BRAMMER, 48 Brecon Avenue, East Cosham, Hants.

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Chairman: PROFESSOR G. H. RAWCLIFFE, M.A., D.SC.

Hon. Secretary: F. F. FREELING, Midlands Electricity Board, Bowling Hill, Chipping Sodbury, Bristol.

Hon. Asst. Secretary (Bristol): W. D. MORGAN, W. T. Glover and Co. Ltd., 123 Victoria Street, Bristol, 1.

Hon. Asst. Secretary (Cardiff): E. B. BACHELOR, 15 Tredelerch Road, Rumney, Cardiff.

Western Supply Group

Chairman: C. J. R. BLACKETT.

Hon. Secretary: A. A. BECKINGSALE, Central Electricity House, 26 Oakfield Road, Bristol, 8.

Local Centre Officers (*contd.*)

Western Utilization Group

Chairman: E. R. RADWAY.

Hon. Secretary: G. M. HUGHES-CALEY, B.T.H. House, 119 Victoria Street, Bristol, 1.

Hon. Asst. Secretary: W. S. EVANS, Docks Engineer's Office, Port of Bristol Authority, Avonmouth, Bristol.

South-Western Sub-Centre

Chairman: W. R. ROWE.

Hon. Secretary: G. B. DEVEY, P.O. Engineering Dept., 23 Victoria Park Road, Exeter.

Hon. Asst. Secretary: S. D. CHAPMAN, 'Hycrest', Highbury Crescent, Plympton, Plymouth.

West Wales (Swansea) Sub-Centre

Chairman: J. L. GRIFFITHS.

Hon. Secretary: J. HARLEY, 'Pendower', Swiss Valley, Llanelly, Carmarthenshire.

Hon. Asst. Secretary: B. R. EVANS, B.SC.(ENG.), Engineering Dept., University College of Swansea, Singleton Park, Swansea.

Oversea Branches

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Chairman: D. H. P. HENDERSON.

Hon. Secretary: L. W. BRAZEL, The Calcutta Electric Supply Corporation Ltd., Victoria House, Calcutta.

CEYLON BRANCH

Chairman: E. C. FERNANDO, M.B.E., B.SC.(ENG.).

Hon. Secretary: M. I. AZIEZ, B.SC., Electrical Engineer, Operations and Maintenance, Dept. of Government Electrical Undertakings, P.O. Box 540, McCallum Road, Colombo, 10.

IRISH BRANCH

Chairman: P. H. GREER.

Hon. Secretary: J. MCKEEVER, B.SC.(ENG.), General Electric Co. Ltd., 13 Trinity Street, Dublin.

Oversea Committees

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New South Wales

Chairman: A. C. H. FROST, B.SC.(ENG.).

Hon. Secretary: J. T. ROLLO, c/o Electricity Commission of N.S.W., Power Development Division, Box 5257, G.P.O., Sydney.

Queensland

Chairman: A. S. FAULKNER.

Hon. Secretary: W. I. GEORGE, B.E., c/o The English Electric Co. Ltd., P.O. Box 406F, G.P.O., Brisbane.

South Australia

Chairman: Appointment pending.

Hon. Secretary: J. W. CROMPTON, B.E., 139 Fisher Street, Malvern.

Victoria and Tasmania

Chairman: J. WILSON.

Hon. Secretary: C. A. P. OLDFIELD, c/o State Electricity Commission of Victoria, 22-32 William Street, Melbourne.

Western Australia

Chairman: K. W. TAPLIN, B.E.

Hon. Secretary and Treasurer: R. R. LAKE, B.E., c/o 132 Murray Street, Perth.

INDIA

Bombay

Chairman: J. H. SMYTH, B.SC.

Hon. Secretary: T. M. SHIVRAM, Services Engineer (North), B.E.S. & T. Undertaking, Electric House, Post Fort, Bombay, 1.

Madras

Chairman: Appointment pending.

Hon. Secretary: R. WRIGHT, M.B.E., 4 Buckingham Gardens, Madras, 12.

MALAYA AND SINGAPORE

Chairman: THE OVERSEA REPRESENTATIVE OF THE COUNCIL.

NEW ZEALAND

Chairman: F. T. M. KISSEL, I.S.O., B.SC.

Hon. Secretary: E. H. R. GREEN, C.B.E., M.SC., Engineer-in-Chief, General Post Office, Wellington, C.1.

SOUTH AFRICA

Transvaal

Chairman and Hon. Secretary: A. W. LINEKER, B.SC., P.O. Box 7794, Johannesburg.

Oversea Representatives of the Council

ARGENTINA

A. C. TOWERS, Acassuso 841, Olivos, F.N.G.B.M., Prov. de Buenos Aires.

BRAZIL

E. WINSTANLEY, B.SC.(ENG.), The Rio de Janeiro Flour Mills and Granaries Ltd., Caixa Postal 486, Rio de Janeiro.

Oversea Representatives of the Council (*contd.*)

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C. H. MELLOR, c/o Rangoon Electric Supply Board, 503/9 Merchant Street, Rangoon.

CANADA

J. M. THOMSON, M.A.SC., PH.D., Ferranti Electric Ltd., Mount Dennis, Toronto 15, Ontario.

CAPE PROVINCE

C. G. DOWNIE, B.SC., c/o City Electricity Dept., P.O. Box 82, Cape Town.

CEYLON

J. G. PARK, Office of the United Kingdom High Commissioner, 7 Prince Street, Colombo.

EAST AFRICA

A. O. COSGROVE, B.SC., The General Electric Co. Ltd., P.O. Box 5100, Nairobi.

FAR EAST

D. S. HILL, Reiss, Bradley and Co. Ltd., National City Bank of New York Building, 2 Queens Road C, Hong Kong.

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INDIA

F. WADE-COOPER, Magnet House, Chittaranjan Avenue, P.O. Box 8974, Calcutta, 13.

Deputy Representative: L. W. BRAZEL, c/o Calcutta Electric Supply Corporation, Calcutta.

ISRAEL

B. F. MOSS, 94 Hayarkon Street, Tel-Aviv.

MALAYA AND SINGAPORE

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Deputy Representative: P. J. TYRRELL, B.SC.(ENG.), The B.T.H. Export Co. Ltd., P.O. Box 151, Kuala Lumpur.

MIDDLE EAST

J. M. MORRIS, O.B.E., The Port Directorate, Basrah, Iraq.

NATAL

R. M. O. SIMPSON, c/o Electricity Dept., P.O. Box 147, Durham.

NEAR EAST

A. G. COATES, I.P.C., P.O. Box No. 150, Tripoli, Lebanon.

Deputy Representative: PROFESSOR R. W. SLOANE, M.A., PH.D., B.SC., Director of Engineering, Experimental and Service Laboratories, American University of Beirut, Division of Engineering, Beirut, Lebanon.

NEW SOUTH WALES

Appointment pending

NEW ZEALAND

E. H. R. GREEN, C.B.E., M.SC., Engineer-in-Chief, General Post Office, Wellington, C.1.

PAKISTAN

K. I. BROWN, M.B.E., c/o Associated Electrical Industries (Pakistan) Ltd., Shernaz House, West Wharf Road, Post Box 4958, Karachi, Pakistan.

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SWITZERLAND

L. W. HAYES, O.B.E., 43 Quai Wilson, Geneva.

TRANSVAAL

A. W. LINEKER, B.SC., P.O. Box 7794, Johannesburg.

UNITED STATES OF AMERICA

Hon. Secretary: R. H. BARCLAY, The J. G. White Engineering Corporation, 80, Broad Street, New York 4, N.Y., U.S.A.

VICTORIA AND TASMANIA

PROFESSOR C. E. MOORHOUSE, M.E.E., Department of Electrical Engineering, University of Melbourne, Carlton, N.3, Victoria.

Deputy Representative for Tasmania: H. P. TUCK, M.E., B.SC., Associate Professor, University of Tasmania, Hobart, Tasmania.

WEST AFRICA

J. HOUSTON ANGUS, P.O. Box 388, Lagos, Nigeria.

WEST INDIES

H. D. WALDEN, B.SC., c/o The Trinidad Oil Co. Ltd., 19 La Carriere Road, Point-a-Pierre, Trinidad.

WESTERN AUSTRALIA

J. B. JUKES, B.E., The State Electricity Commission of Western Australia, Electricity House, 321 Murray Street, Perth.

Joint Oversea Groups

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Hon. Secretary and Treasurer: J. COOMBES, A.M.I.C.E., c/o Percy Grant & Co., Reconquista 314, Buenos Aires, Argentina.

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Chairman: A. W. BLACK, M.I.MECH.E.
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IRAQ AND PERSIAN GULF
Chairman: J. M. MORRIS, O.B.E., A.M.I.MECH.E., M.I.E.E.
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SINGAPORE/MALAYAN
Chairman: S. A. ANDERSON, M.I.MECH.E.
Hon. Secretary: C. G. V. RUDD, M.SC., A.M.I.MECH.E., A.M.I.E.E., Alliance Engineering Co. Ltd., 6/7 Telegraph Street, Singapore.

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Hon. Secretary: D. P. J. HOLBROOK, B.SC.(ENG.), A.M.I.E.E., c/o Trinidad Oilfield Service Ltd., P.O. Box 69, San Fernando, Trinidad.

WEST AFRICA
Chairman: R. BRIDGMAN, M.I.C.E.
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Hon. Secretary: A. D. FLEET, Equipment Engineering Dept., Westinghouse Brake and Signal Co. Ltd., New Road, Chippenham, Wilts.

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Chairman: H. C. TUCKER.
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Hon. Secretary: A. WREN, Lancashire Dynamo and Crypto Ltd., 10 King John's Chambers, Bridlesmith Gate, Nottingham.

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Chairman: E. HARTLEY.
Hon. Secretary: E. F. F. GILLESPIE, M.ENG., 61 Lyminster Road, Sheffield, 6.

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SOUTH MIDLAND
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Chairman: D. W. MARTIN.
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Mersey and North Wales Centre	*D. A. Picken*
North-Eastern Centre	*J. F. Skipsey, B.Sc.*
North Midland Centre	*J. R. Rylands, M.Sc., J.P.*
Sheffield Sub-Centre	*F. Seddon*
North-Western Centre	
North Lancashire Sub-Centre	*G. K. Alston, B.Sc.(Eng.*
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Scottish Centre	*R. H. Dean, B.Sc.Tech.*
North Scotland Sub-Centre	*P. Philip*
South Midland Centre	*Capt. J. H. Patterson, R.A.*
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South-Western Sub-Centre	*W. E. Johnson*

Oversea Attendance Register

During the period 1st May to 31st May the following members called at the Institution building and signed the Attendance Register of Oversea Members:

ANDREW, C. R. (Ipoh, Malaya)
BUNKER, A. F. (Melbourne)
CANHAM, MISS J. J. D., B.SC.(ENG.) (Accra)
CLIMIE, P. R., B.SC. (Christchurch, New Zealand)
COLEMAN, W. F., B.SC.(ENG.) (Accra)
CRANSWICK, C. A., B.SC.(ENG.) (Salisbury, S. Rhodesia)
DEB, S. B., M.SC. (Calcutta)
HARRIS, F. H. (Singapore)
HART, D. B. (Wellington, New Zealand)
HOWE, R. L. (Nairobi)
KNAPP-FISHER, R. N. (Manitoba)
LANGTON, L. L. (Salisbury, S. Rhodesia)
LEE, J. H., M.C., B.SC.(ENG.) (Wellington, New Zealand)
MELLANBY, J., M.A. (Accra and Ibadan)
PAXTON, L. A. (Salisbury, S. Rhodesia)
SARKAR, K. R. (Calcutta)
SCOTT, W. G., B.SC. (Ipoh)
SIDDAWAY, T. (Singapore)
STOCK, J. M., O.B.E., M.ENG. (Kampala)
SMITH, W. E. (Nairobi)
STURGESS, N. H., B.SC.(ENG.) (Johannesburg)
THOMAS, L. W., B.SC. (Washington, D.C.)